### 1.2.8 COAL GRINDING AND SLURRY PREPARATION - UNIT 24

#### A. Basis of Design

The Texaco slurry preparation technique utilizes wet grinding technology which does not require drying of the coal prior to slurrying. Design of the coal slurry unit was based on a summary of the criteria listed below:

(1) Top size of coal particles controlled for compatibility of downstream equipment.

(2) Provide a coal particle size distribution as specified for gasifier feed.

(3) Concentration of solids controlled close to the slurry concentration specified for the gasifier feed.

The selection of equipment provides a high degree of control on particle size and water balance in the slurry. These were important design features required to produce a pumpable slurry of the desired concentration.

The Coal Grinding and Slurry Preparation Unit has parallel grinding trains arranged compatibly with those of the TCGP.

**Feed Stream**

| Component | Total Coal Feed (lb/hr) |
|---|---|
| Coal | 480,225 |
| Water | 46,919 |
| Total | 527,144 |
| Average Solids Density | 1.444 |
| Particle Size | 2" x 0 |
| Temperature °F | Ambient |

## B. Process Selection Rationale

The process selection of the Texaco Coal Gasification Process (TCGP) was specified by W.R. Grace & Co. prior to the initial phase of the preliminary design of the Coal-to-Methanol-to-Gasoline Plant. The slurry preparation system is considered to be an integral part of the Texaco Coal Gasification Process and contains proprietary data; specifically, the coal grind distribution and slurry concentration. This confidentiality extends to equipment associated with producing this size distribution.

The Demonstration Plant (SGDPP contract between W.R. Grace & Co. and DOE) design incorporated wet grinding. However, at this stage of the program in 1979, the impact of oversize material on the performance of the Texaco gasifier had not been demonstrated, particularly the impact of a slurry on a steady flow through the high-pressure positive displacement pumps. Therefore, until this problem could be investigated in more detail, the Demonstration Plant design included the necessary facilities to provide a positive system for removal of oversize material from the product grind. Similar coal grinding for slurry transportation is a proven technology, largely developed in the United States.

Experience with Texaco gasifiers at Montebello and at Oberhausen-Holten continued during the time period that elapsed between the SGDPP work and the Gasoline Plant Project. Design of the coal slurry unit for the Gasoline Plant was based on criteria established by Texaco.

## C. Process Description

The arrangement of equipment and material balance for this unit is shown on Process Flow and Control Diagrams D-24-MP-101NP, -102NP, and -103NP.

The design of the coal slurry unit is based on criteria set out by Texaco as indicated above in the Basis of Design.

The Coal Grinding and Slurry Preparation Unit has parallel grinding trains. The grinding trains have a common header, linking the trains to the slurry holding tanks.

An 8,700-ton covered live day storage in silos is the source of feed to the coal grinding trains. Raw coal 2 inches and under is reclaimed from a silo by a discharge feeder and transferred to a belt conveyor for feeding to a grinding train. An individually controlled variable flow of coal is used for each of the grinding trains. Provisions were made in the coal surge storage for downtime of mill trains caused by maintenance.

Each train was designed to handle 2-inch coal containing 8.9% moisture at normal operating rates ranging from 118 to 151 tons per hour, 24 hours per day, 7 days per week. Design coal feed rate was set at 200 tph. This rate permits normal production of slurry from the grinding trains for the normal operating condition with design coal, even if the spare grinding train is out of service.

The 2-inch and under coal conveyed from each live storage silo is fed to a first-stage reduction mill for reduction. Feed to the impact type crusher discharges from a 30-inch belt conveyor operating at about 260 fpm. The coal discharges from the head pulley through a chute and drops vertically to the first-stage reduction mill. Crushed material is removed by a belt conveyor to a revolving mill. Coal is weighed during transport to the mill on a belt scale.

This digital weigher records the coal flow and provides a signal to control water addition to the mill and also to the feeding arrangement in the coal day storage in Unit 12 to ensure a uniform flow rate that can be varied from 70 to 200 tph. The coal is sampled automatically as it is discharged from the conveyor head pulley by gravity to a cone for feeding to the revolving mill.

Fresh coal feed is mixed with a recycle slurry from Unit 21 plus makeup water and a viscosity additive. Water is added in proportion to the weight of coal feed determined by the belt scales. The desired coal-ash-water proportion in the mill discharge varies by weight according to coal type.

Slurry overflow from the mill passes through a trommel screen and is discharged to a surge sump. The trommel screen has openings to remove tramp material. The reject on the screen is discarded. A meter in the sump monitors slurry viscosity and transmits this information to the plant control system, where it is tied in with the mill water feed controls.

The slurry is pumped from the mill sump to a safety screen for scalping of tramp material from the slurry product, thereby ensuring adequate protection to downstream equipment from oversize material. The oversized material removed by the screen deck is sluiced back to the feed cone of the mill using a portion of the makeup water. The slurry passing through the screen deck flows by gravity to a screen sump and is pumped to agitated slurry holding tanks.

The slurry tanks are positioned adjacent to each other with a tie-between. If one of the tanks is out of service, the flow to the other is increased. These tanks are designed for working volume storage of 4 hours at a normal operating level that permits over another hour's storage up to a maximum liquid level, leaving adequate freeboard allowance.

Working volume calculations are predicated on maintaining a minimum operating level to provide proper submergence of bottom propeller. A tank may be emptied below that level, but the agitator is turned off to prevent damage to the shaft. A slurry feeding pump circulates slurry from the slurry tanks to the suction side of the gasifier charge pumps.

The preceding description covers the operation of the slurry preparation subsystem when producing the Texaco grind specification for normal operating conditions. The Operating Costs Summary is based on the standard grind specification which is used over 85% of the time.

Texaco uses additives in coal slurries to improve slurry viscosity and increase solids concentration. Consequently, a slurry additive system was incorporated in the slurry preparation unit. Storage capacity provides for a maximum of 30 days' storage. One unloading pump handles the unloading stations.

One area sump and pump are provided. Spills and floor cleanup in the slurry preparation building are sent to the gasification unit and are pumped back along with the gasifier recycle.

For some coals, it may be necessary to add basic material to the slurry to prevent corrosion because of low pH. Provision was made to add ammonia, if needed, to the water line to the mill at plant startup. Such addition ceases after the operating system reaches steady state pH of about 8.0.

## D. Risk Assessment

This system includes impact cruchers, wet grinding mills, wet vibrating screens, slurry tanks, slurry pumps, and belt conveyors. All equipment selected for coal grinding and slurry preparation is conventional, commercially available, and has a history of successful operation with coal or in other applications. All pumps are spared. Lines and equipment have appropriate corrosion-erosion allowances, along with wear plates according to accepted slurry handling practice.

Built-in slurry holding capacity in process sumps provides a buffer against slurry surge from mills and screens in case of power failure. Slurry pH is held slightly basic by automatic monitoring and controlling the pH of the recycle streams.

The Coal Grinding and Slurry Preparation Unit is comprised of parallel grinding trains. The trains have a common header, linking the trains to the slurry holding tanks.

The unit was designed in a particularly conservative manner; that is, to provide a range of potential grind analyses. This provides the possibility of varying the grind size to suit slurry concentration, carbon conversion, and gasifier performance for a wide range of coal analyses.

Based on experience with other coals, the equipment is not expected to encounter undue clogging or plugging problems. The vibrating screen for each train is a safety or scalping screen to remove tramp or oversize product, thereby furnishing protection against oversize material that might interfere with operation in downstream equipment. The screen has a built-in feed splitter to produce three feedstreams. Each of these streams is sent to one of three separate screening sections of the multifeed screen. Each screen is spared as further insurance against screen blinding.

The areas of uncertainty include the ability to produce on a continuous basis the coal slurry required for the normal operating condition case without containing oversize solids and the ability to handle these coal slurries. A system is incorporated to provide an additive ahead of the grinding mill for modifying slurry viscosity. Screens are subject to blinding at higher solids concentration and are spared. The handling of coal slurries and suspension of solids particles in water are arduous applications for valving. Special attention was applied to the detail of valve design to ensure long-term continuous operation without undue maintenance.

The coal grinding and slurry preparation system must deliver coal, ground to the proper grind size specification, while still achieving the design slurry concentration. Failure to meet either of these desired conditions results in difficulties in the process units downstream of the unit, principally in gasification. To a considerable extent, downstream facilities were designed to compensate for deviation in slurry concentration.

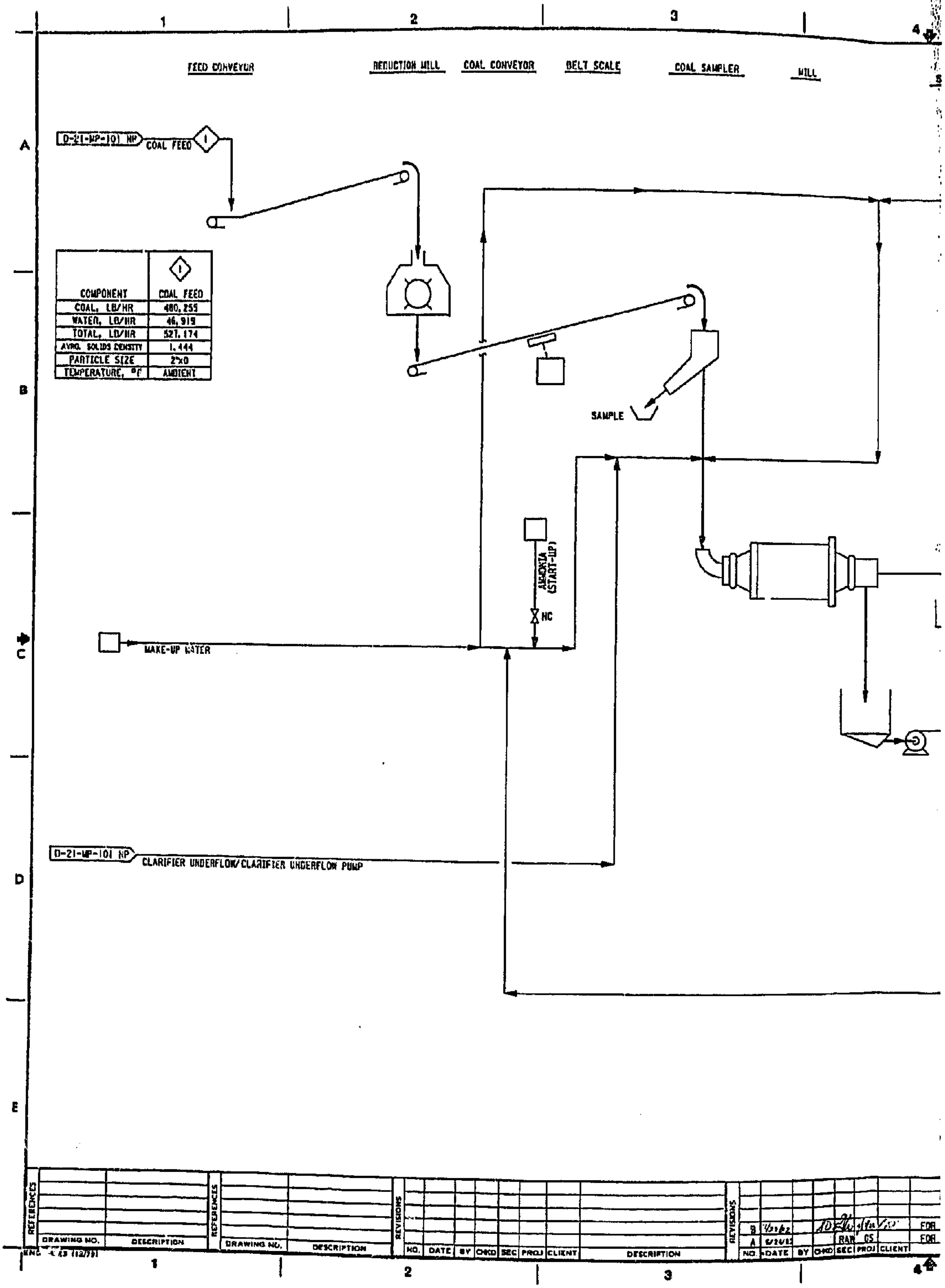
A flexible coal grinding system was designed to produce the required grind size distribution and slurry concentration, while at the same time protecting against oversize particles. This permits the capability of producing a divergence of coal grind size distributions. This approach gives the plant the capability of tailoring the grinding system to optimize the overall gasification system performance.

The coal slurry presents special problems for high-pressure charge pumps. Some experience was obtained in the Texaco pilot plant where equivalent coal slurries were pumped to the gasification pressure of 1,200 psig. It is preferable to use pumps with no water dilution. A number of suppliers are available for selection on this basis.

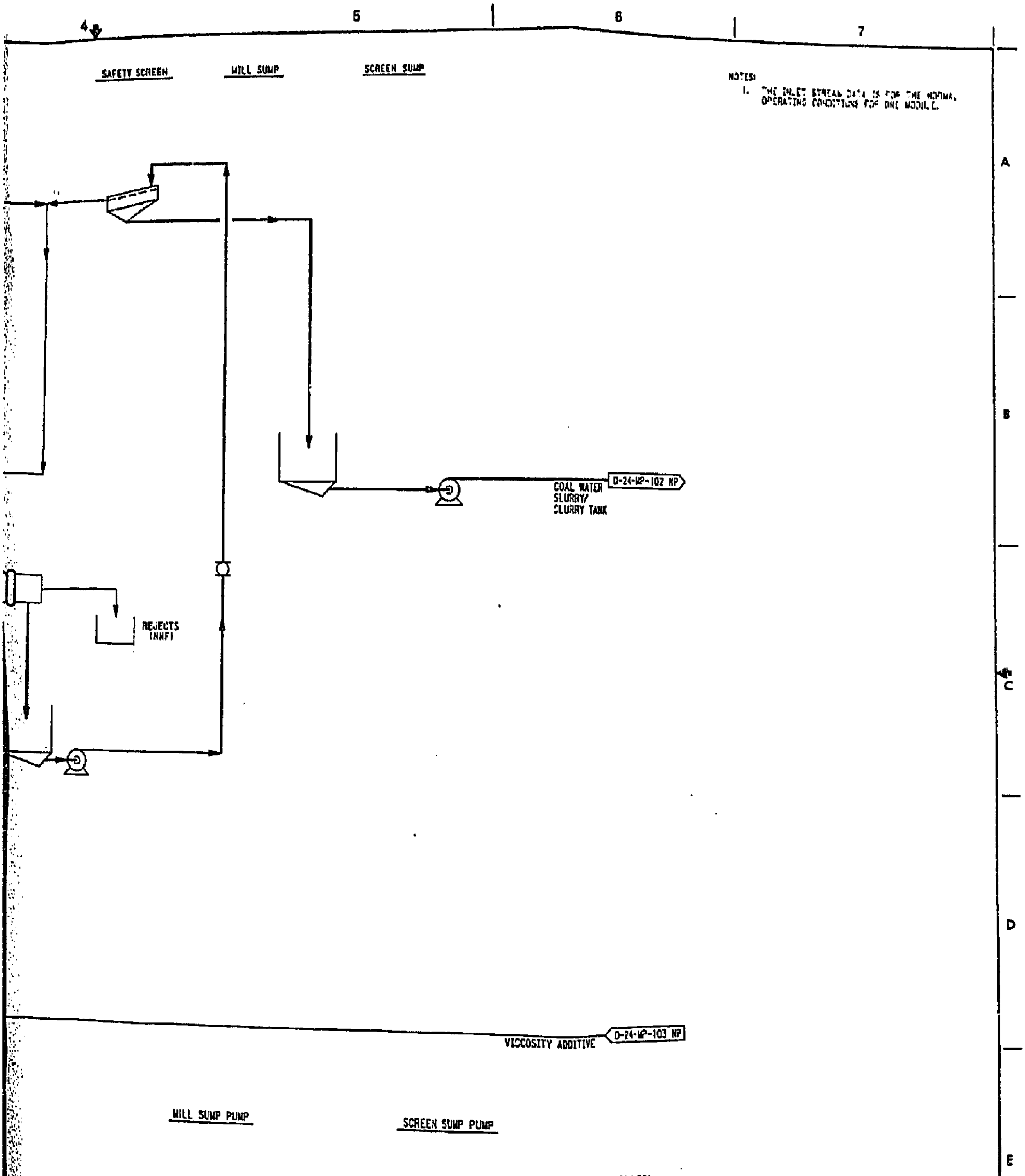
## E. Process Flow and Control Digrams (Including Material Balance)

Process Flow and Control Diagrams for Coal Grinding and Slurry Preparation Unit 24 are as follows:

| Drawing No. | Title |
|---|---|
| D-24-MP-101NP | PFCD Coal Grinding and Slurry Preparation Unit 24 - Coal Grinding |
| D-24-MP-102NP | PFCD Coal Grinding and Slurry Preparation Unit 24 - Slurry Preparation |
| D-24-MP-103NP | PFCD Coal Grinding and Slurry Preparation Unit 24 - Viscosity Additive System |



| COMPONENT | 1<br>COAL FEED |
|---|---|
| COAL, LB/HR | 480,255 |
| WATER, LB/HR | 46,919 |
| TOTAL, LB/HR | 527,174 |
| AVRG. SOLIDS DENSITY | 1.444 |
| PARTICLE SIZE | 2"x0 |
| TEMPERATURE, °F | AMBIENT |



NOTES:

1. THE INLET STREAM DATA IS FOR THE NORMAL OPERATING CONDITIONS FOR ONE MODULE.

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COAL - TO - METHANOL - TO - GASOLINE PLANT

TITLE
PROCESS FLOW AND CONTROL DIAGRAM
COAL GRINDING & SLURRY PREPARATION
UNIT 24
COAL GRINDING

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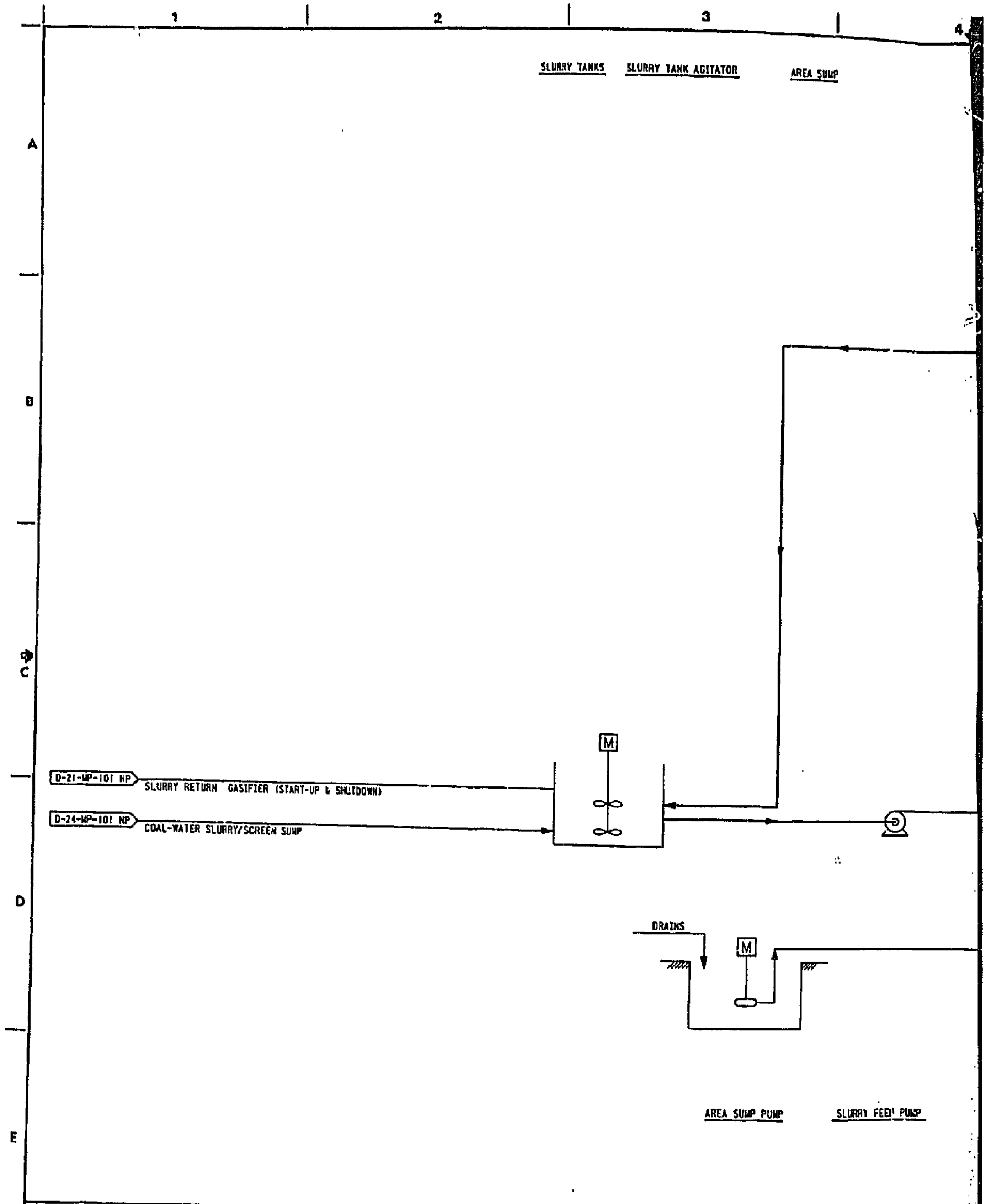

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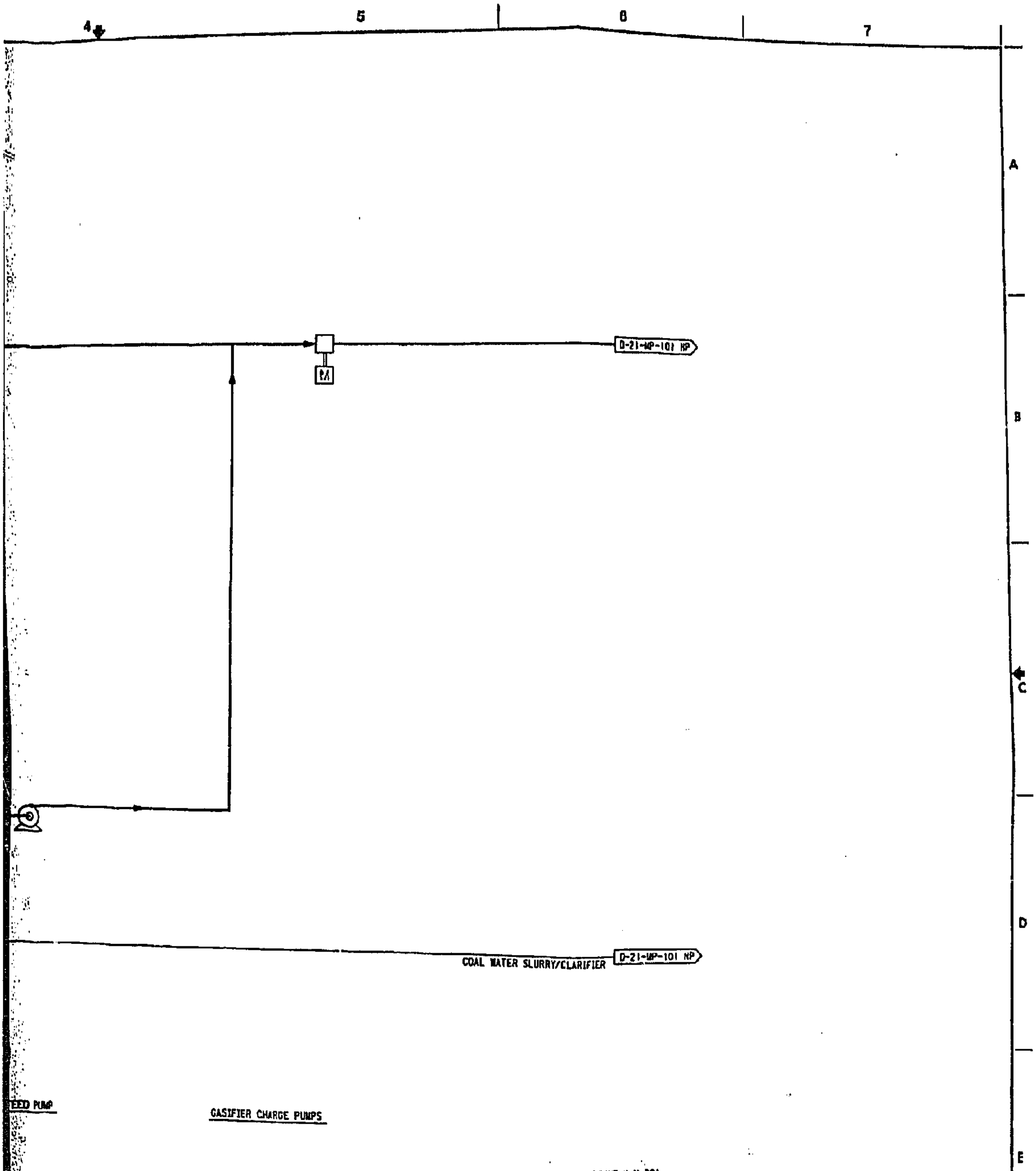

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TITLE
COAL GRINDING AND SLURRY PREPARATION
UNIT 24
SLURRY PREPARATION

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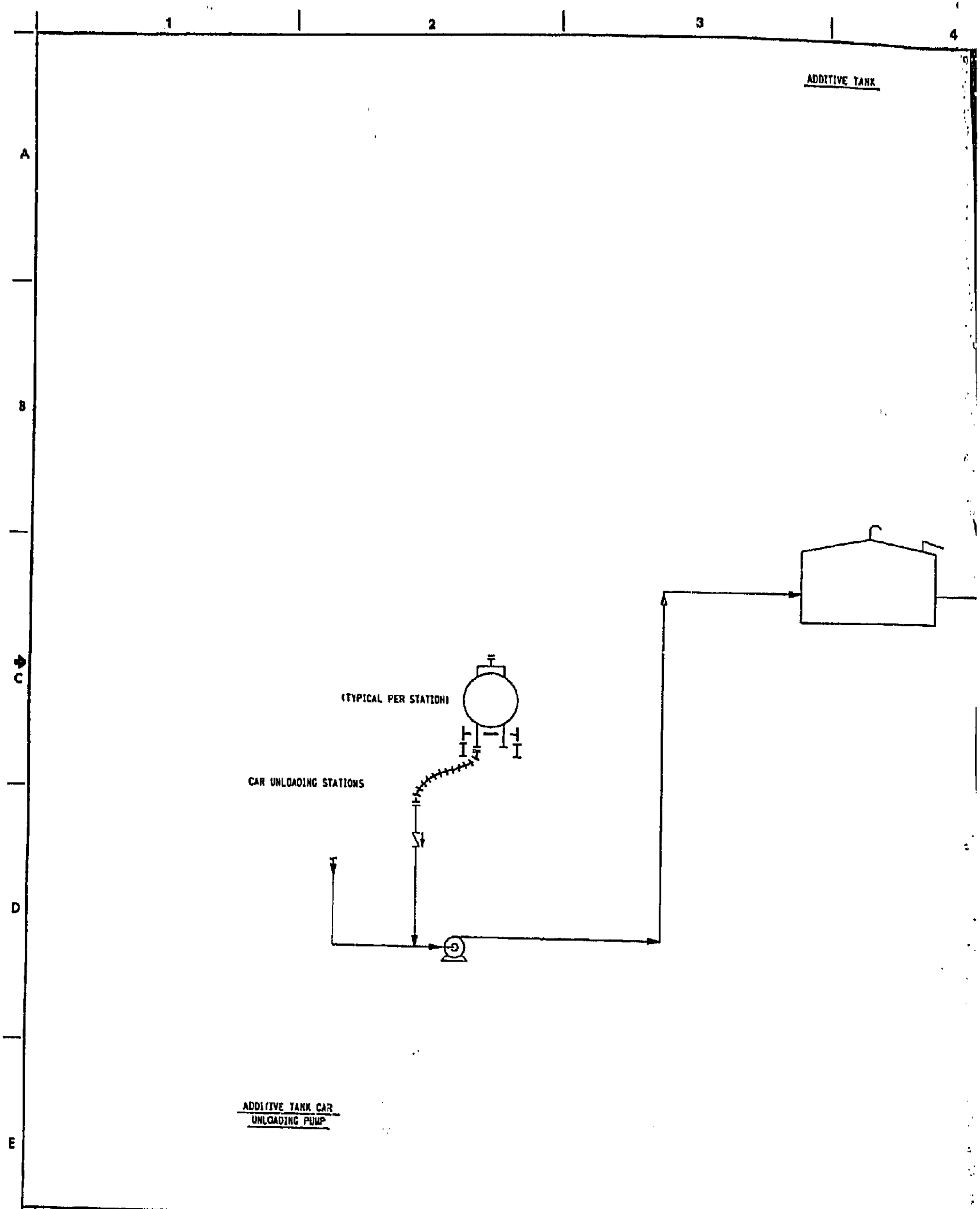

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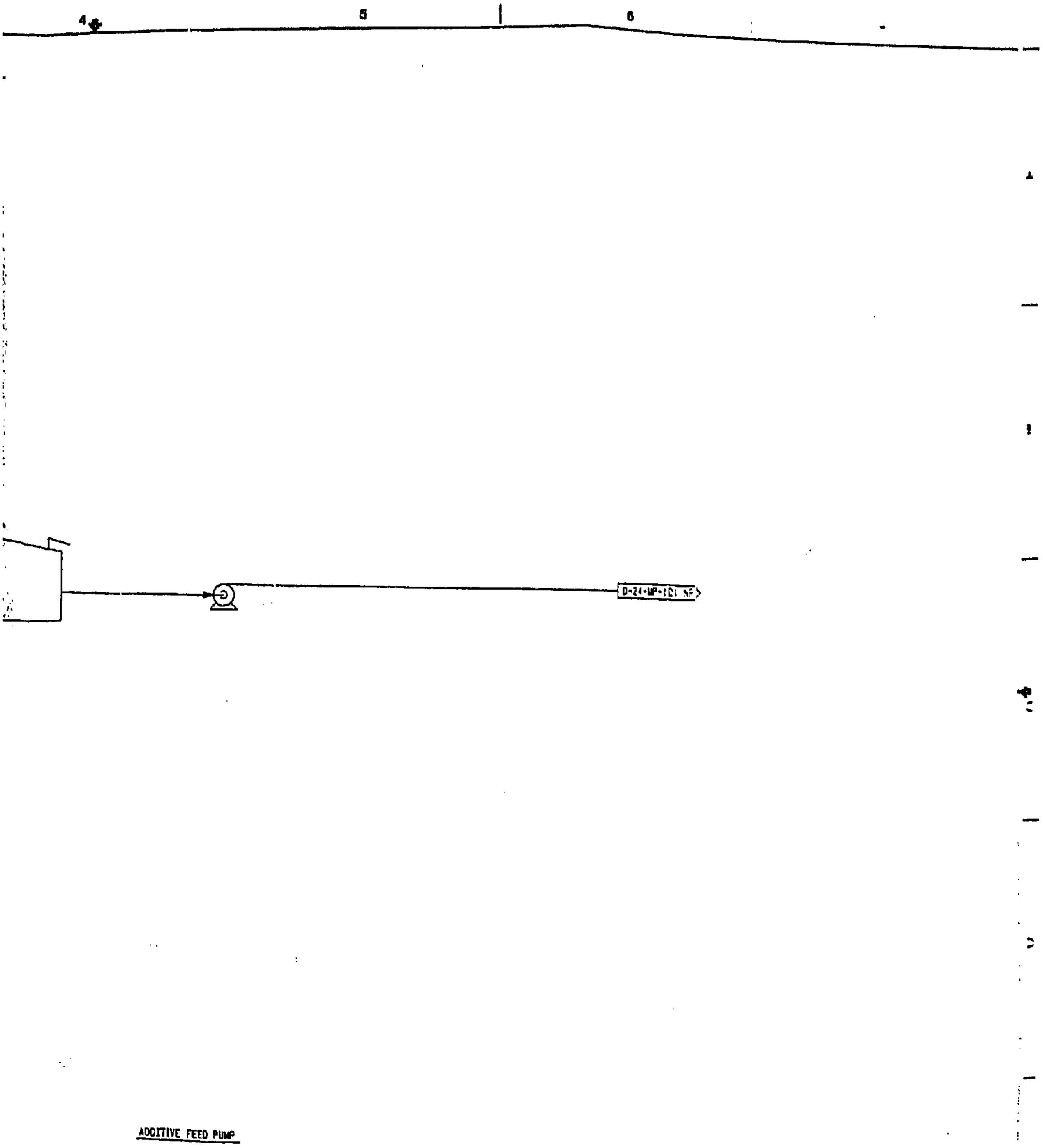

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PROCESS FLOW AND CONTROL DIAGRAM
COAL GRINDING & SLURRY PREPARATION-
UNIT 24
VISCOSITY ADDITIVE SYSTEM

NONE

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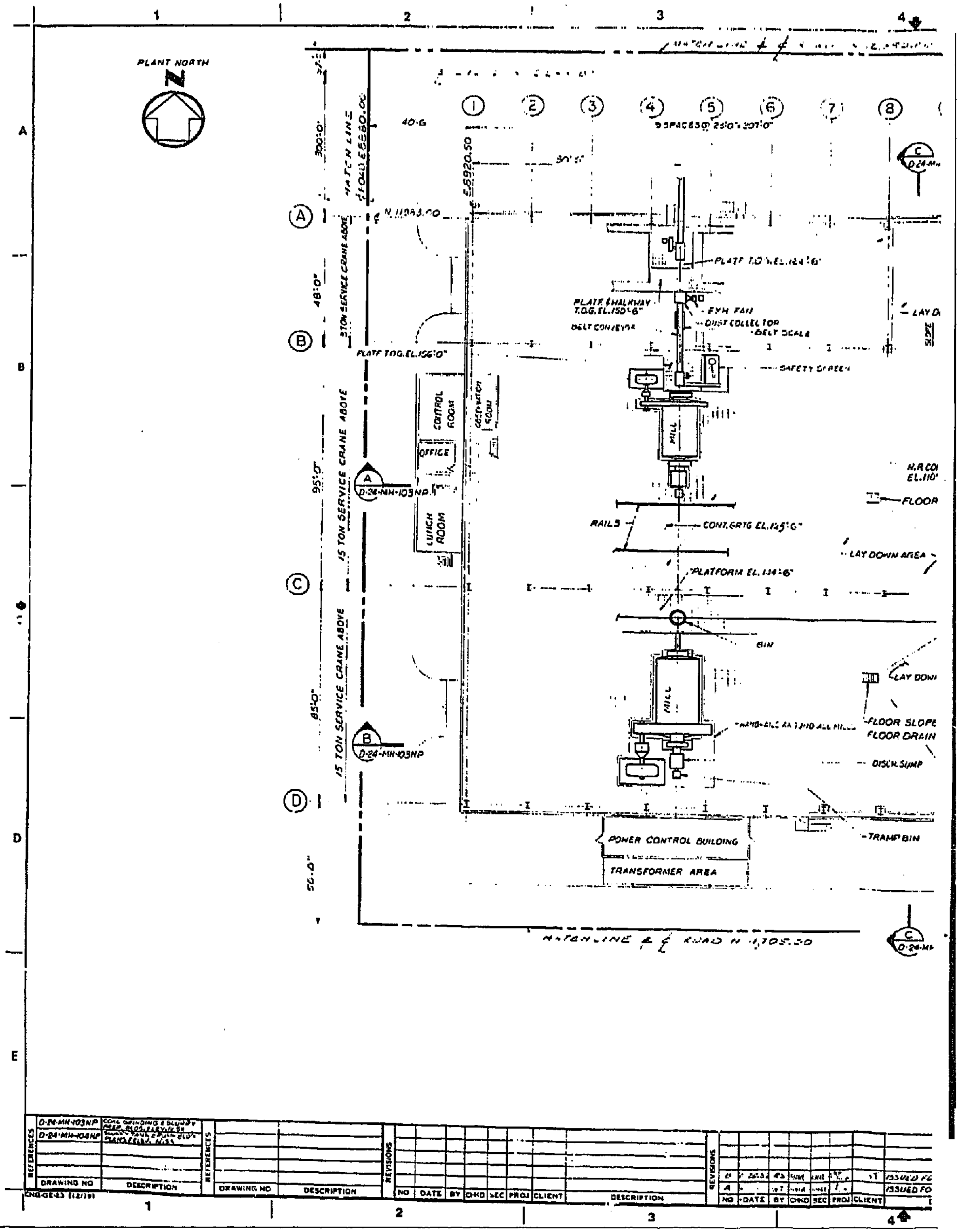
### F. Plot Plan/General Arrangement Drawings

Plot Plan/General Arrangement Drawings for Coal Grinding and Slurry Preparation Unit 24 are as follows:

| Drawing No. | Title |
|---|---|
| D-24-MH-102NP | General Arrangement Coal Slurry and Grinding - Unit 24 Slurry Preparation Building - Plan |
| D-24-MH-103NP | General Arrangement Coal Slurry and Grinding - Unit 24 Slurry Preparation Building - Sections |
| D-24-MH-104NP | General Arrangement Coal Slurry and Grinding - Unit 24 Slurry Tanks and Pump Building - Plan and Section |


PLANT NORTH
N
MATCH LINE
E 5880.00
E 5920.50
N 11383.00
40'-6
30'-0"
48'-0"
95'-0"
85'-0"
56'-0"
9 SPACES @ 25'-0" = 225'-0"
5 TON SERVICE CRANE ABOVE
15 TON SERVICE CRANE ABOVE
15 TON SERVICE CRANE ABOVE
PLATF. T.O.G. EL. 124'-6"
PLATF. & WALKWAY T.O.G. EL. 150'-6"
BELT CONVEYOR
EXH. FAN
DUST COLLECTOR
BELT SCALE
PLATF. T.O.G. EL. 156'-0"
SAFETY SCREEN
CONTROL ROOM
OPERATION ROOM
OFFICE
LUNCH ROOM
MILL
A
D-24-MH-103NP
B
D-24-MH-103NP
C
D-24-MH
RAILS
CONT. GRTG EL. 125'-6"
PLATFORM EL. 134'-6"
BIN
MILL
FLOOR SLOPE
FLOOR DRAIN
DISCH. SUMP
LAY DOWN AREA
LAY DOWN
LAY DO
SLOPE
H.R. CO
EL. 110'
FLOOR
TRAMP BIN
POWER CONTROL BUILDING
TRANSFORMER AREA
MATCH LINE & ℄ ROAD N 11,105.50
A
B
C
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REFERENCES
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SLURRY TANK & PUMP BLDG. PLAN & ELEV. N.S.S.
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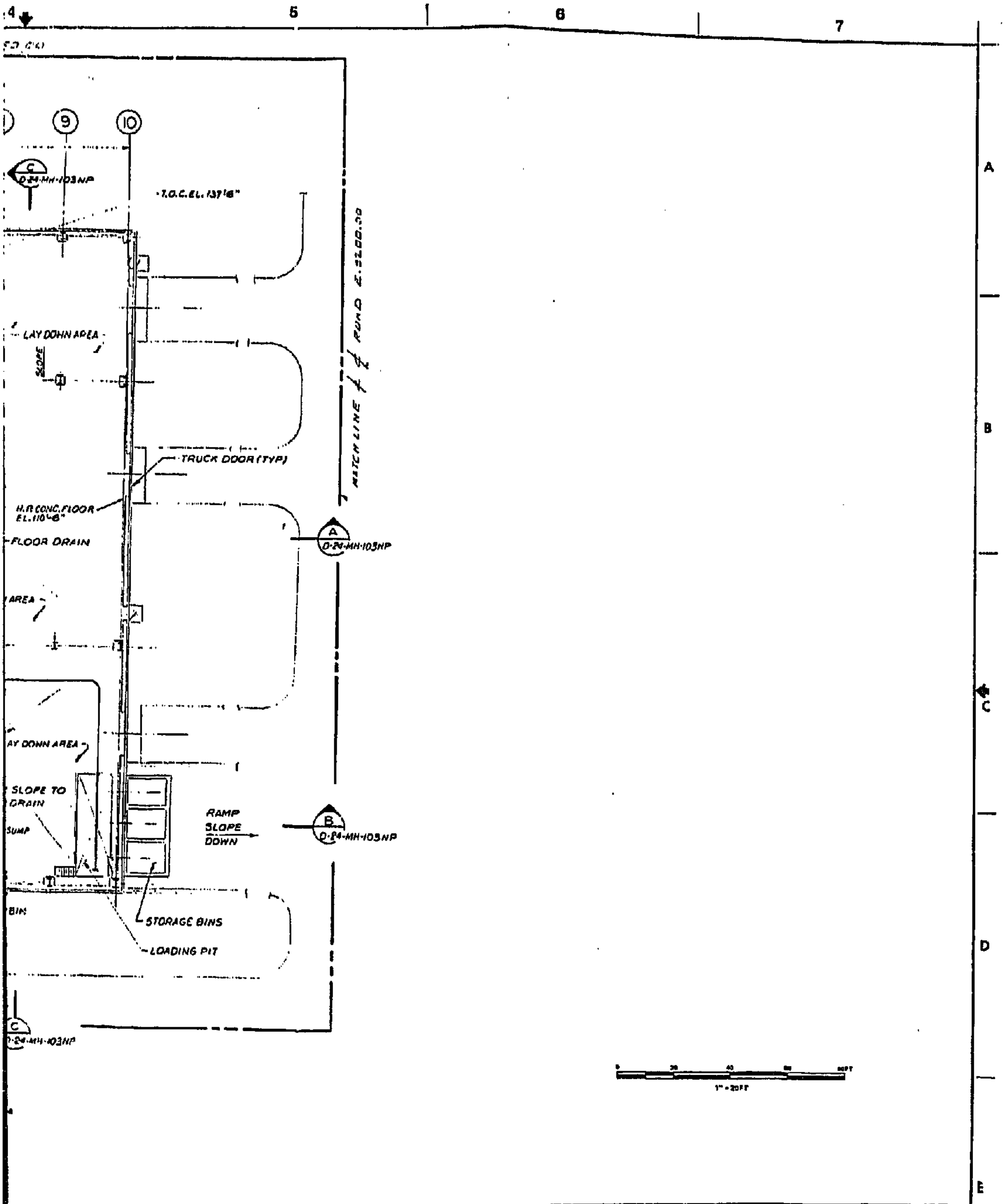

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TITLE GENERAL ARRANGEMENT
COAL SLURRY & GRINDING – UNIT 24
SLURRY PREPARATION BUILDING
PLAN

| SCALE | ACCOUNT NUMBER | JOB NUMBER | REVISION |
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| 1" = 20'-0" | 2000 | 6182 | △ |

DOCUMENT NUMBER D-24-MH-102 NP

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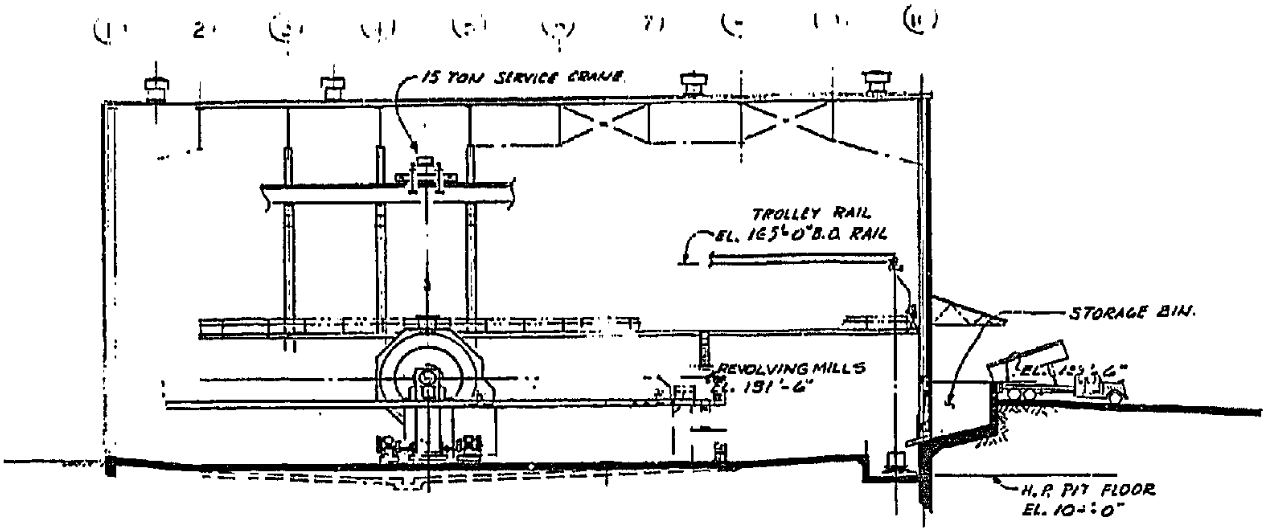

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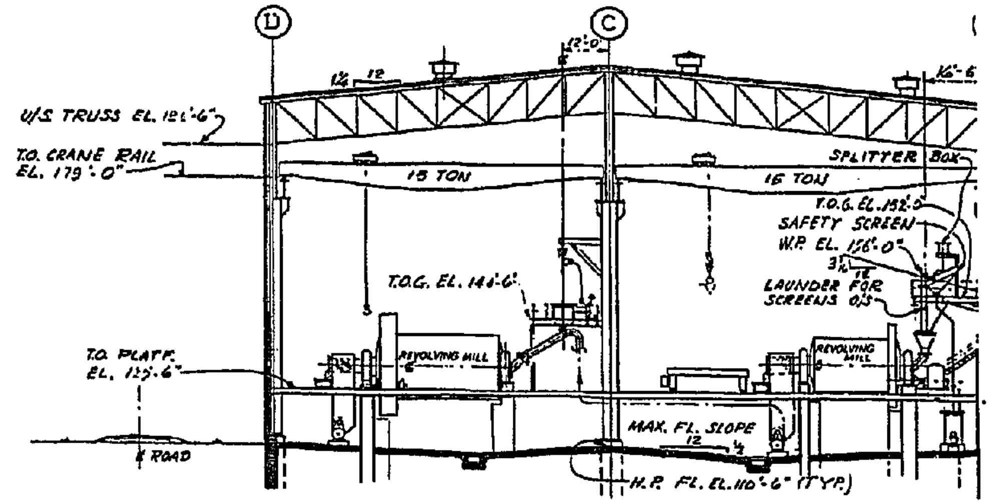

SECTION (C) REF MH-103 NP 24-MH-102 N.P.

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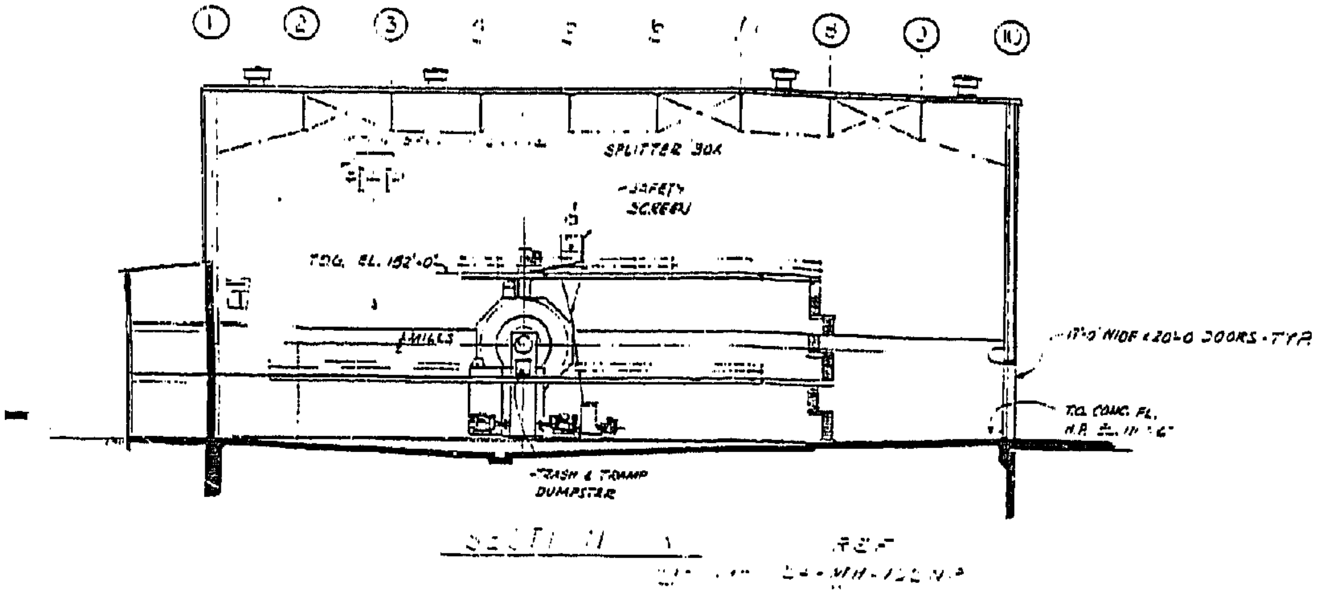

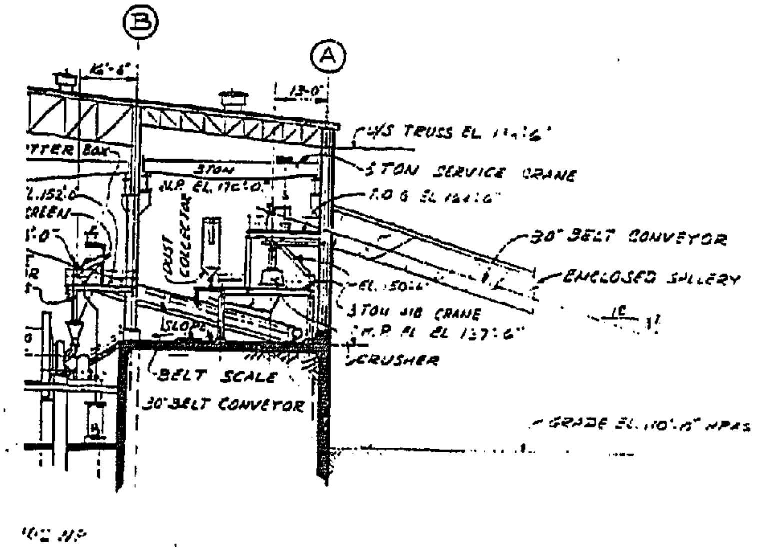

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COAL - TO - METHANOL - TO - GASOLINE PLANT

GENERAL ARRANGEMENT
COAL SLURRY AND GRINDING - UNIT 24
SLURRY PREPARATION BUILDING
SECTIONS

| SCALE | ACCOUNT NUMBER | JOB NUMBER | REVISION |
|---|---|---|---|
| 1" = 20'-0" | 2000 | 6182 | 3 |

D-24-MH-103NP

THE RALPH M. PARSONS COMPANY
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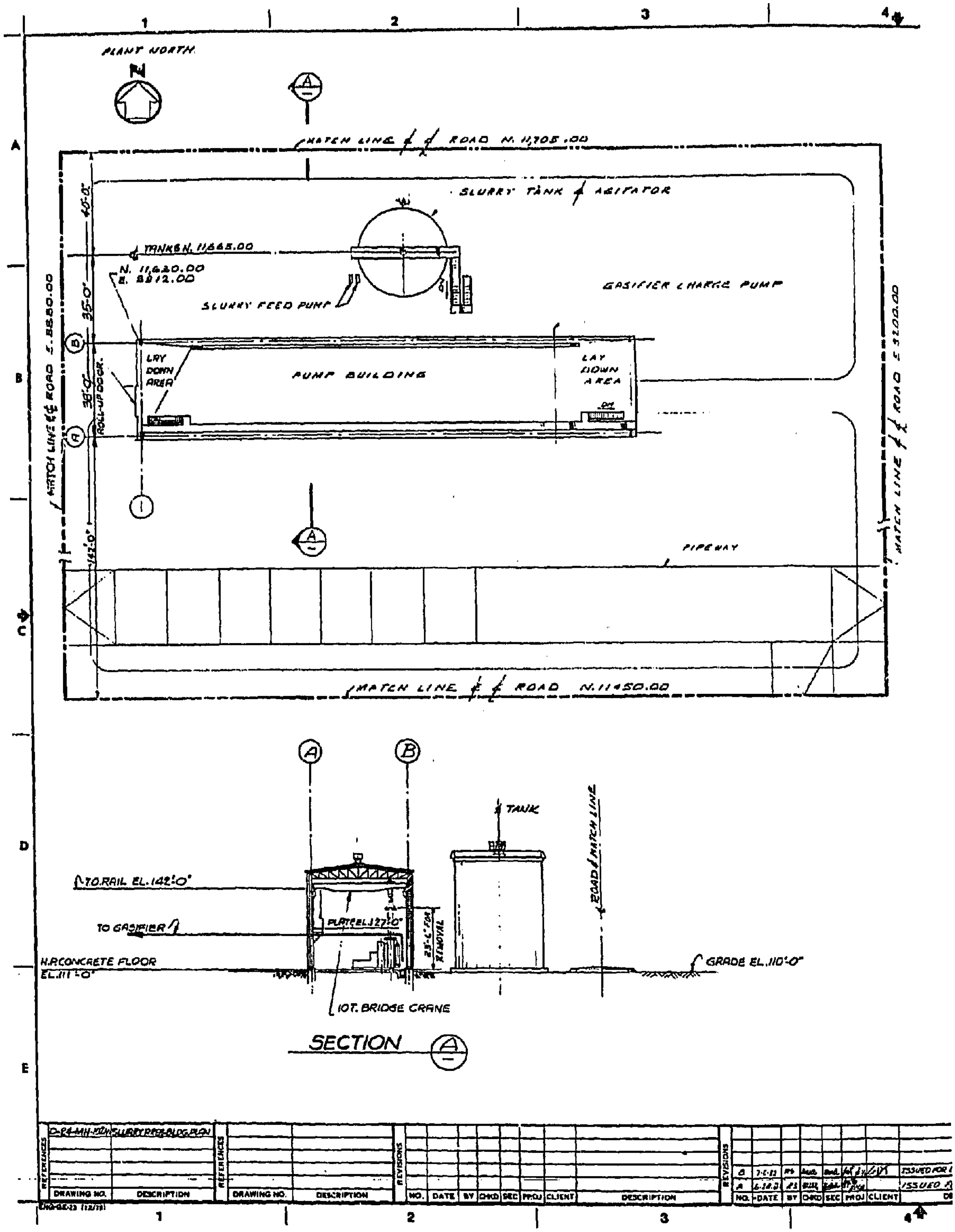
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PLANT NORTH
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A
MATCH LINE ℄ ℄ ROAD N. 11,705.00
SLURRY TANK ℄ AGITATOR
℄ TANK N. 11,665.00
N. 11,620.00
E. 8812.00
SLURRY FEED PUMP
GASIFIER CHARGE PUMP
40'-0"
35'-0"
30'-0"
MATCH LINE ℄ ℄ ROAD E. 8880.00
MATCH LINE ℄ ℄ ROAD E. 9100.00
ROLL-UP DOOR
LAY DOWN AREA
PUMP BUILDING
LAY DOWN AREA
B
A
1
142'-0"
PIPEWAY
MATCH LINE ℄ ℄ ROAD N. 11450.00
A
B
℄ TANK
ROAD ℄ MATCH LINE
T.O. RAIL EL. 142'-0"
TO GASIFIER
PLAT'F EL. 127'-0"
23'-6" FOR REMOVAL
H.P. CONCRETE FLOOR EL. 111'-0"
GRADE EL. 110'-0"
10T. BRIDGE CRANE
SECTION A
REFERENCES
D-24-MH-1124 SLURRY PREP. BLDG. PLAN
DRAWING NO.
DESCRIPTION
REFERENCES
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DESCRIPTION
REVISIONS
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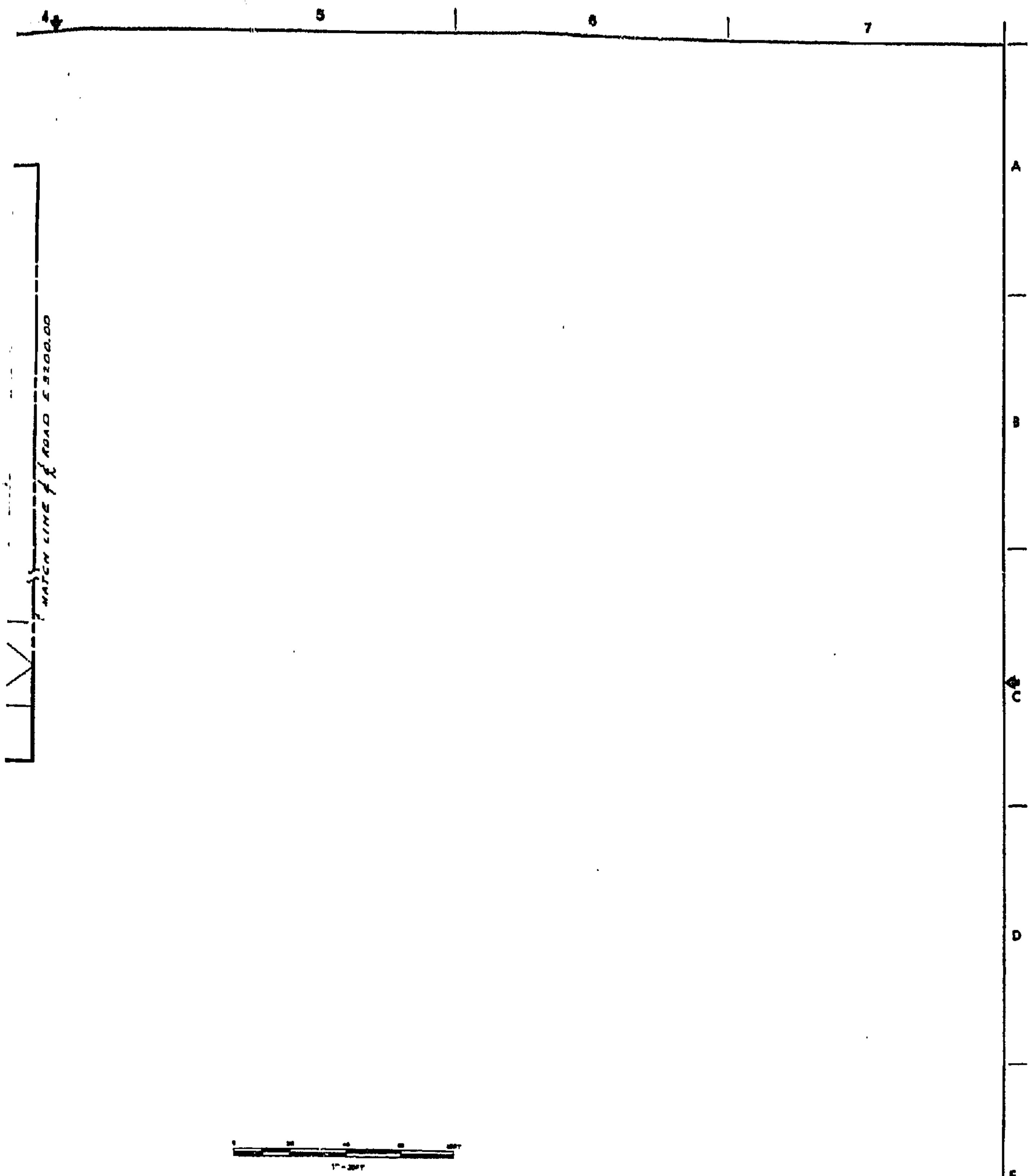

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| CLIENT | DESCRIPTION | APVD CLIENT | | |

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COAL - TO - METHANOL - TO - GASOLINE PLANT

TITLE
GENERAL ARRANGEMENT
COAL SLURRY & GRINDING - UNIT 24
SLURRY TANKS & PUMP BUILDING
PLAN & SECTION

SCALE 1"=20'-0 | 2000 | 6182

DOCUMENT NUMBER D-24-MH-104 NP

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### G. Single-Line Diagram

See Volume II, 1.2.5(G), for Coal Grinding and Slurry Preparation Unit 24 single-line diagram.

## 1.2.9 METHANOL SYNTHESIS - UNIT 25

A Lurgi methanol synthesis unit has been selected to convert synthesis gas, after partial CO shift and acid gas removal, to methanol. Approximately 4,250 stpd of methanol are required to produce the nominal 12,500 bpd of gasoline. A single train is provided with two reactors in parallel.

Also included is a single-train Pressure Swing Adsorption (PSA) facility. The PSA design is based on Union Carbide's HYSIV process.

### A. Basis of Design

Based on experience and proven technology, a single train is designed to convert synthesis gas to methanol. Because of physical constraints on equipment size, the train has two reactors in parallel.

Feed, product, and fuel/purge gas by-product stream compositions are given in the following tables.

## Feed Streams

| Component | Makeup Gas<br>lb mol/hr | mol% |
|---|---|---|
| $H_2$ | 24,203.44 | 67.54 |
| $CH_4$ | 80.65 | 0.22 |
| CO | 10,206.60 | 28.48 |
| $CO_2$ | 1,075.13 | 3.00 |
| $N_2$ | 203.55 | 0.57 |
| Ar | 68.32 | 0.19 |
| Total Dry, lb mol/hr | 35,837.69 | 100.00 |
| $H_2O$ | - | |
| Total Wet, lb mol/hr | 35,837.69 | |
| Total, lb/hr | 391,734 | |
| Pressure, psia | 750 | |
| Temperature, °F | 82 | |

## Product Streams

| Component | "Wild" Methanol |  | Crude Methanol[a] |  |
|---|---|---|---|---|
|  | (lb mol/hr) | (mol%) | (lb mol/hr) | (mol%) |
| $H_2$ | 29.83 | 0.24 | 0.14 | 12 ppmv |
| $CH_4$ | 14.55 | 0.12 | 0.31 | 26 ppmv |
| CO | 5.48 | 0.05 | 0.07 | 5 ppmv |
| $CO_2$ | 72.72 | 0.60 | 7.28 | 0.06 |
| $N_2$ | 12.22 | 0.10 | 0.10 | 9 ppmv |
| Ar | 7.66 | 0.06 | 0.10 | 9 ppmv |
| $CH_3OH$ | 11,023.20 | 90.59 | 10,923.52 | 91.55 |
| Hydrocarbons | 0.18 | 16 ppmv | 0.13 | 11 ppmv |
| High Boilers | 13.26 | 0.11 | 13.20 | 0.11 |
| Low Boilers | 9.28 | 0.08 | 7.99 | 0.07 |
| $H_2O$ | 980.12 | 8.05 | 978.38 | 8.20 |
| Total, lb mol/hr | 12,168.50 | 100.00 | 11,931.22 | 100.0 |
| Total, lb hr | 376,429 |  | 369,153 |  |
| Pressure, psia | 415 |  | 10 |  |
| Temperature, °F | 100 |  | 94 |  |

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[a] Composition of methanol produced when the MTG unit is down and "wild" methanol is let down to 10 psia prior to storing in crude methanol tank.

## By-products

| Component | Flash Gas From "Wild" Methanol (lb mol/hr) | Flash Gas From "Wild" Methanol (mol%) | Flash Gas From Crude Methanol[a] (lb mol/hr) | Flash Gas From Crude Methanol[a] (mol%) |
|---|---|---|---|---|
| $H_2$ | 67.69 | 61.56 | 29.69 | 12.60 |
| $CH_4$ | 7.49 | 6.82 | 14.24 | 6.05 |
| CO | 4.99 | 4.53 | 5.42 | 2.30 |
| $CO_2$ | 7.19 | 6.54 | 65.45 | 27.79 |
| $N_2$ | 15.34 | 13.95 | 12.11 | 5.14 |
| Ar | 6.12 | 5.56 | 7.56 | 3.21 |
| $CH_3OH$ | 1.12 | 1.01 | 99.68 | 42.32 |
| Hydrocarbons | - | - | 0.04 | 0.02 |
| High Boilers | - | - | 0.06 | 0.03 |
| Low Boilers | 0.03 | 0.03 | 1.28 | 0.54 |
| Total Dry, lb mol/hr | 109.97 | 100.00 | 235.53 | 100.00 |
| $H_2O$ | 0.01 | | 1.74 | |
| Total Wet, lb mol/hr | 109.98 | | 237.27 | |
| Total, lb/hr | 1,425 | | 7,268 | |
| Pressure, psia | 45 | | 10 | |
| Temperature, °F | 100 | | 94 | |

---

[a] Flash gas from crude methanol is produced when methanol is sent to storage.

By-products (Contd)

| Component | Purge Gas (lb mol/hr) | (mol%) | Leakage Gas (lb mol/hr) | (mol%) |
|---|---|---|---|---|
| $H_2$ | 870.82 | 71.43 | 125.65 | 69.98 |
| $CH_4$ | 54.02 | 4.43 | 4.58 | 2.55 |
| CO | 43.54 | 3.57 | 24.55 | 13.67 |
| $CO_2$ | 34.17 | 2.80 | 5.34 | 2.97 |
| $N_2$ | 161.49 | 13.25 | 14.51 | 8.08 |
| Ar | 50.16 | 4.11 | 4.39 | 2.44 |
| $CH_3OH$ | 4.96 | 0.41 | 0.55 | 0.31 |
| Total Dry, lb mol/hr | 1,219.16 | 100.00 | 179.57 | 100.00 |
| $H_2O$ | 0.01 | | - | |
| Total Wet, lb mol/hr | 1,219.17 | | 179.57 | |
| Total, lb/hr | 12,032 | | 1,849 | |
| Pressure, psia | 994 | | 750 (max) | |
| Temperature, °F | 100 | | 127 | |

## B. Process Selection Rationale

Data were requested from ICI, Lurgi, and Topsoe for a 17,000-stpd methanol plant for this project. Such data, together with meetings with each of the potential licensors and information available from other sources, formed the bases of a process selection study. Based on an evaluation against predetermined criteria, the Lurgi process was selected for incorporation in the gasoline plant. Key attributes of the Lurgi process contributing to its selection are as follows:

(1) Lurgi's methanol plant experience based on synthesis gas from heavy oil gasification as well as from natural gas reforming. At the present time, there are four operating plants using vacuum or heavy residue and four others are under construction. Also one plant using coal as feedstock is under construction in the United States. This is supported by Lurgi's extensive experience with coal and coal gasification through its own process - and Lurgi's experience in Rectisol acid gas removal plants prior to methanol synthesis.

(2) The Lurgi process, because of its special reactor design, recovers heat at a higher temperature level.

(3) The Lurgi process utilizes an isothermal reactor which enables optimization of catalyst and recycle gas requirements.

## C. Process Description

Refer to Process Flow and Control Diagrams D-25-MP-101NP, -102NP, -103NP, and -104NP for equipment arrangement and material balance.

The synthesis gas coming from the Acid Gas Removal Unit is compressed in Makeup Gas Compressor 25-01-1801 from 750 psia to 998 psia. The gas is added to the recirculating gas, and the two gases are compressed to synthesis pressure in Recycle Gas Compressor 25-01-1802.

The gas is heated to 437°F in Feed/Effluent Exchangers 25-01-1301 and -1302 by a portion of the hot reactor effluent gas in countercurrent flow.

Conversion of $H_2$ with CO and $CO_2$ to methanol takes place in Synthesis Reactors 25-01-2501 and -2502, which are equipped with parallel vertical tubes holding the catalyst. The heat released during the exothermic conversion reaction is transferred in situ to boiling water, which ensures exact temperature control and eliminates damage to the catalyst caused by overheating. The reactor outlet temperature is regulated easily and closely by controlling the pressure in Steam Drums 25-0' 1201 and -1202.

As already mentioned, a portion of the hot reactor effluent gas heats the reactor inlet gas. Boiler Feedwater Preheater 25-01-1303 is installed in parallel with the interchangers to preheat the boiler feedwater in countercurrent flow to the remaining reactor effluent gas. Further cooling of the gas and condensation of methanol and water occur in Air Coolers 25-01-1304 and -1305 and Water Coolers 25-01-1306 and -1307. To avoid an accumulation of inerts in the synthesis loop, the system is purged continuously, with the purge gas being routed to either PSA Unit 25-01-2801 or the plant fuel gas system. The condensate is separated in Methanol Separator 25-01-1203 and supplied by level control to Flash Drum 25-01-1204, where raw methanol is expanded to 415 psia. Flash gases released by this expansion are routed to the fuel gas header and, under normal operating conditions, the resultant "wild" methanol flows to Methanol-to-Gasoline Unit 31.

When the MTG unit is down, "wild" methanol is expanded further to 10 psia in Low-Pressure Flash Drum 25-01-1205. Low-Pressure Flash Drum Pump 25-01-1503 supplies crude methanol to the crude methanol tank in Intermediate Tankage - Unit 63. Low-Pressure Flash Drum Eductor 25-01-2802 uses purge gas to produce a vacuum in the low-pressure flash drum. Flash gases from the low-pressure letdown flow to the fuel gas system.

## D. Risk Assessment

Compressed synthesis gas from the Acid Gas Removal Unit is mixed with the recycle gas from the product separator and compressed to synthesis pressure. Synthesis gas is charged to the reactor after heat exchange with the reactor effluent. The design of the isothermal methanol synthesis reactor is based on experience in the construction of Fischer-Tropsch plants. The exothermic conversion of hydrogen with carbon monoxide and carbon dioxide to methanol takes place in the tubes filled with copper-based catalyst. The reaction heat is used to generate steam from the boiler water surrounding the tubes. The reaction mixture exchanges the major portion of its sensible heat with the reactor feed in a heat exchanger. It is cooled to ambient temperature with air and cooling water and sent to the product separator. "Wild" methanol is produced after the product separator bottoms is flashed at medium pressure and sent to the MTG plant.

Lurgi's methanol synthesis process is a highly commercialized, efficient, and reliable process. Makeup gas and recycle gas compressors are key items, but operating pressures and flows are not extreme. Service is clean and nonfouling.

The outstanding features of the methanol synthesis catalyst are high-conversion efficiency, long life, and almost complete suppression of side reactions. The methanol reactor may be compared to a shell-and-tube heat exchanger with no mechanically moved part in the overall reactor system.

The catalyst temperature in the synthesis reactor is controlled by the vapor pressure of the evaporating boiler water around the tubes, which ensures that the copper catalyst is not exposed to extreme temperatures. This would result in premature aging of the catalyst caused by recrystallization of the copper. The reactor design and the reactor control of the catalyst temperature by steam pressure offers the following major advantages:

- Constant catalyst temperatures even at upset operating conditions by maloperation.

- Gentle catalyst treatment by avoiding excessive temperatures and sudden temperature changes.

- Almost complete utilization of the reaction heat for high-pressure steam generation.

- Excellent turndown ratio.

- High flexibility regarding variations of CO and $CO_2$ content in the synthesis gas.

Although the catalyst is sensitive to sulfur, commercial operation of this type of reactor design in conjunction with Rectisol units has shown that sulfur poisoning is not a problem.

The technical risk of methanol synthesis by the Lurgi process is judged to be very low.

### 1.2.9-1 PRESSURE SWING ADSORPTION (PSA) UNIT

The Heavy Gasoline Treating (HGT) unit used to reduce durene in the finished gasoline to about 2 wt% durene requires a small flow of high-purity hydrogen. A PSA unit produces this hydrogen stream from the methanol synthesis purge stream.

#### A. Basis of Design

Feed to the PSA unit is the purge gas stream from the methanol synthesis unit. Product hydrogen is fed to the HGT unit to catalytically hydrotreat a heavy gasoline stream. The PSA purge or tail gas is sent to the plant fuel gas system. Feed, product, and tail gas compositions are shown below.

### Feed and Product Streams

| Component | PSA Feed (lb mol/hr) | Hydrogen Product (lb mol/hr) | PSA Tail Gas (lb mol/hr) |
|---|---|---|---|
| $H_2$ | 141.50 | 82.26 | 59.24 |
| $CH_4$ | 8.78 | Trace | 8.78 |
| CO | 7.08 | Trace | 7.08 |
| $CO_2$ | 5.53 | - | 5.53 |
| $N_2$ | 26.24 | 0.06 | 26.18 |
| Ar | 8.16 | 0.02 | 8.13 |
| $CH_3OH$ | 0.81 | - | 0.81 |
| Total dry, lb mol/hr | 198.10 | 82.34 | 115.75 |
| $H_2O$ | 8 ppm | - | 8 ppm |
| Total wet, lb mol/hr | 198.10 | 82.34 | 115.75 |
| Total, lb/hr | 1,955.0 | 168.4 | 1,786.8 |
| Pressure, psia | 994 | 650 | 60 |
| Temperature, °F | 100 | 110 | 100 |

## B. Process Selection Rationale

The process selection of PSA was made to meet the requirement by Mobil for a 99.9 purity hydrogen for hydrotreating use in the HGT unit. The principal supplier of technology meeting this requirement is Union Carbide.

## C. Process Description

The basic PSA process is one in which impurities are absorbed from the feed gas at high pressure and then are desorbed at low pressure. The process operates on a repeated cycle having two basic steps - adsorption and regeneration. There is no change in temperature except for that caused by the heat of adsorption and desorption.

The Union Carbide HYSIV PSA unit employs a patented Pressure Swing Adsorption process to purify a crude hydrogen feedstream and produce a high-purity hydrogen product stream. The process uses four adsorbent beds to provide a continuous and constant hydrogen product flow. One adsorber is always on adsorption while the other three are in various stages of regeneration. During the adsorption step, feed gas enters the bottom of the adsorber and all impurities are adsorbed. High-purity hydrogen product is available at the top of the adsorber at 2 to 3 psi less than the feed pressure. Following the adsorption step, an adsorber is regenerated in four basic steps:

(1) The adsorber is depressurized in a direction cocurrent with the feed flow to a low-pressure level. This cocurrent flow is used to repressurize and purge other adsorbers.

(2) The adsorber is depressurized in a countercurrent direction to waste pressure and remove impurities from the system.

(3) The adsorber is purged at low pressure with pure hydrogen (from another adsorber) to complete the removal of impurities from the adsorbent.

(4) The pressure of the adsorber is raised to adsorption pressure with pure hydrogen in preparation for another adsorption step.

Operation of the PSA unit is completely automatic with all control valves being actuated by an electric/pneumatic control system. Controls are provided to regulate internal system pressures and flows. The capacity of the unit can be varied from 100% of design to zero by varying the hydrogen withdrawal rate.

The hydrogen product is available at constant flow, pressure, and temperature. Hydrogen recoveries can be maintained at a flow rate as low as 30% of rated design flow. At the lower withdrawal rates, the hydrogen recovery decreases unless the cycle time is increased.

## D. Risk Assessment

Over 190 PSA hydrogen units have been constructed worldwide during the past 15 years or are currently under construction. Seven units have been designed to process a methanol purge stream.

The PSA unit can be operated with any production rate desired, from 100% of design down to zero flow, while maintaining product hydrogen purity. It is the feature of operating at zero hydrogen flow that allows the PSA unit to recover rapidly from upsets caused by changes in the feed condition. The PSA unit can be started up or shut down instantaneously. For longer shutdown periods, a short purging procedure may be necessary. A weekend shutdown with immediate restart without purging is common practice with some PSA units.

The operation of the PSA unit is automatic and requires no direct operator attention. The adsorbers switch automatically through the various cycle steps. These steps are controlled by time delay relays and pressure switches. If the feed rate is increased or decreased, the cycle time may be adjusted to obtain maximum performance. This adjustment may be made at the PSA control panel or from a remote location.

The PSA unit shuts down automatically on cycle advance failure, loss of instrument air, or loss of adsorption pressure. Each adsorber is isolated at the pressure corresponding to its particular step in the cycle sequence at the time of shutdown. Thus, all adsorbers are ready for subsequent startup.

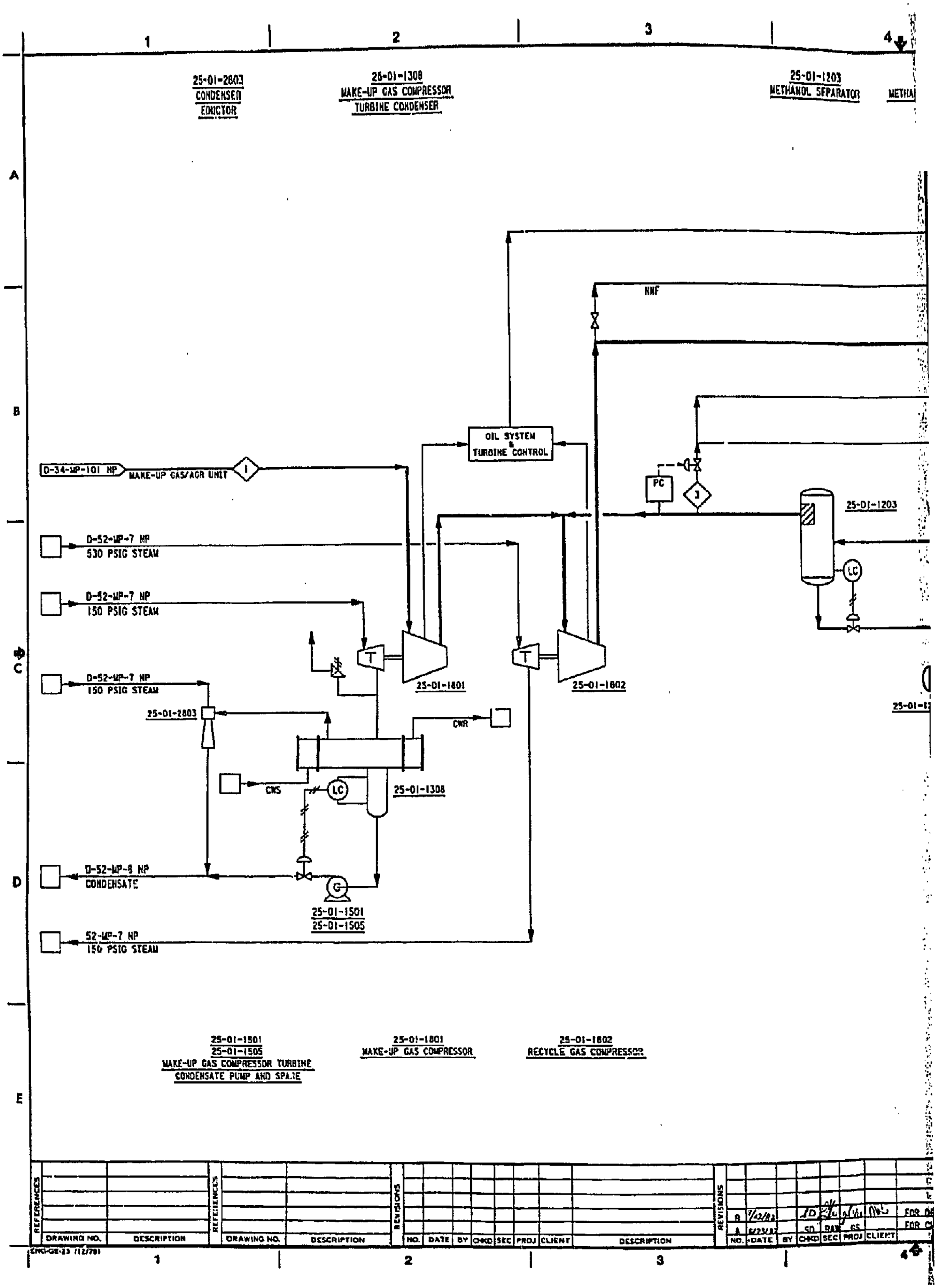
The only moving parts in the PSA unit are control components and automatic valves. Considerable care has gone into selection of the various controls and valves. The proposed design is the result of over 15 years of continual updating based on field-operating experience. Union Carbide's most recent survey of operating units showed that the average onstream availability of the units between scheduled shutdowns exceeded 99.8%.

Units built in the last several years have shown even better reliability and experience periods well in excess of 1 year between unscheduled shutdowns. No physical deterioration or reduction in adsorbent capacity of the adsorbent has been observed in any of the existing units. This covers a period of over 15 years. Union Carbide concludes from this that the life of the adsorbent is good for the life of the equipment.

### E. Process Flow and Control Diagrams (Including Material Balance)

Process Flow and Control Diagrams for Methanol Synthesis Unit 25 are as follows:

| Drawing No. | Title |
|---|---|
| D-25-MP-101NP | PFCD Methanol Synthesis - Unit 25 Gas Compression |
| D-25-MP-102NP | PFCD Methanol Synthesis - Unit 25 Gas Reaction |
| D-25-MP-103NP | PFCD Methanol Synthesis - Unit 25 Pressure Swing Adsorption |
| D-25-MP-104NP | Material Balance Methanol Synthesis - Unit 25 |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25-01-2803
CONDENSER EDUCTOR
25-01-1308
MAKE-UP GAS COMPRESSOR TURBINE CONDENSER
25-01-1203
METHANOL SEPARATOR
METHA
KNF
OIL SYSTEM & TURBINE CONTROL
D-34-MP-101 HP
MAKE-UP GAS/AGR UNIT
1
PC
3
25-01-1203
D-52-MP-7 HP
530 PSIG STEAM
D-52-MP-7 HP
150 PSIG STEAM
LC
T
25-01-1801
T
25-01-1802
25-01-1
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150 PSIG STEAM
25-01-2803
CWR
CWS
LC
25-01-1308
D-52-MP-8 HP
CONDENSATE
G
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25-01-1505
52-MP-7 HP
150 PSIG STEAM
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25-01-1802
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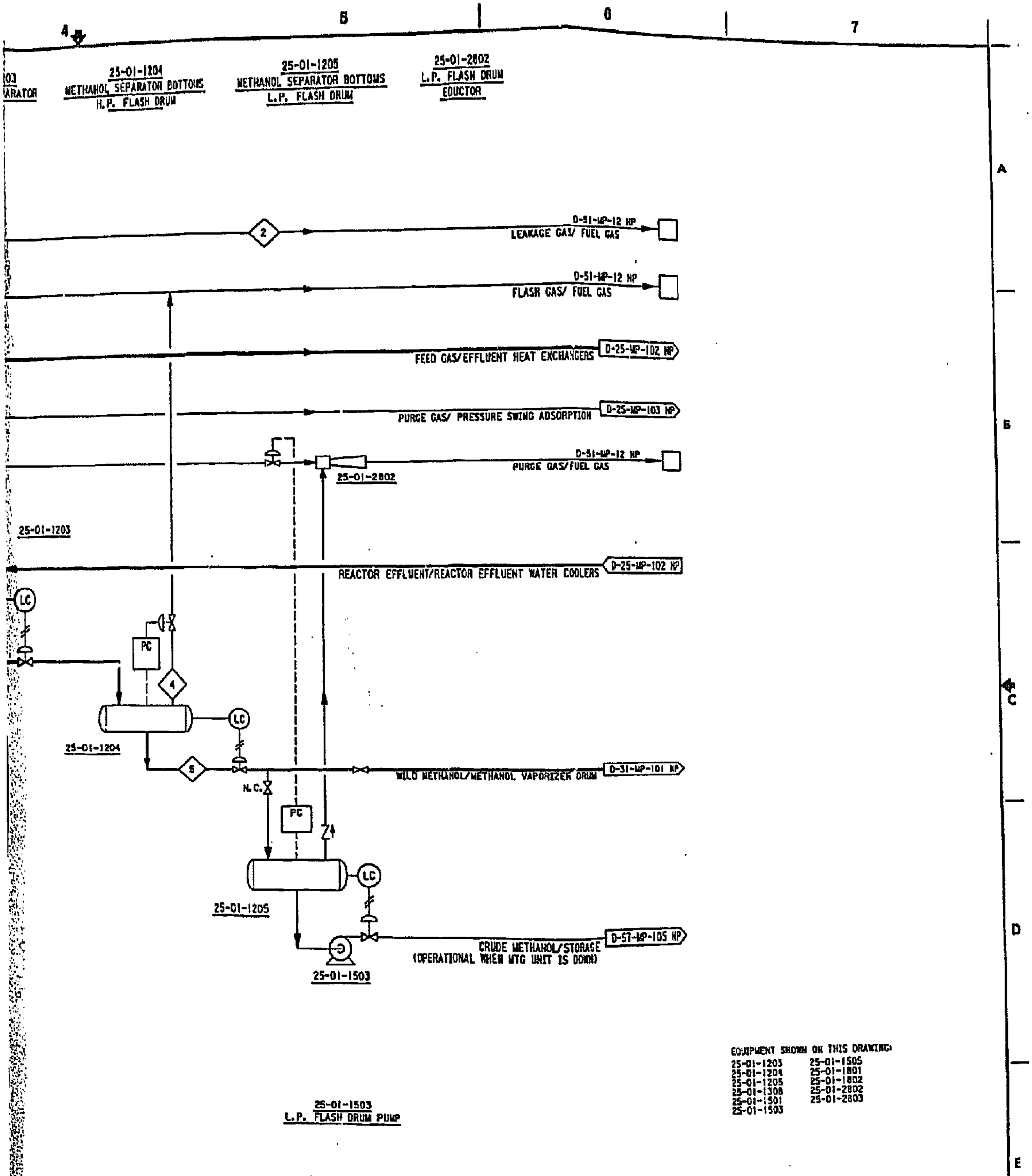

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| 25-01-1205 | 25-01-1802 |
| 25-01-1308 | 25-01-2802 |
| 25-01-1501 | 25-01-2803 |
| 25-01-1503 | |

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LURGI Lurgi Kohle und Mineraloeltechnik GmbH

THE RALPH M. PARSONS COMPANY
PASADENA, CALIFORNIA

U.S. DEPARTMENT OF ENERGY

BASKETT **W.R. GRACE & CO.** KENTUCKY
12,500 B.P.D.
COAL - TO - METHANOL - TO - GASOLINE PLANT

TITLE
PROCESS FLOW AND CONTROL DIAGRAM
METHANOL SYNTHESIS - UNIT 25
GAS COMPRESSION

| SCALE | ACCOUNT NUMBER | JOB NUMBER | REVISION |
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DOCUMENT NUMBER D-25-MP-101 NP

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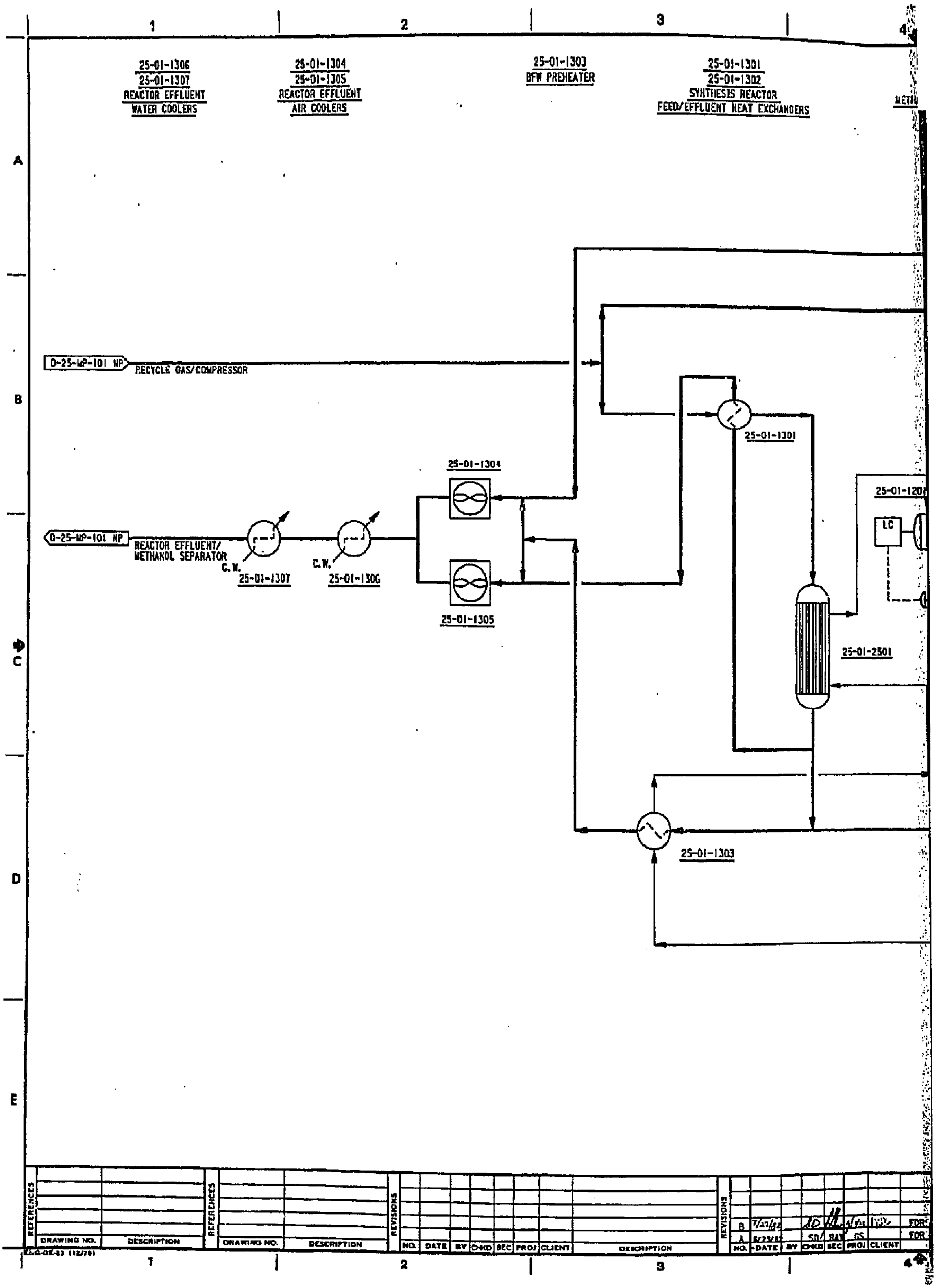
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WATER COOLERS
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25-01-1305
REACTOR EFFLUENT
AIR COOLERS
25-01-1303
BFW PREHEATER
25-01-1301
25-01-1302
SYNTHESIS REACTOR
FEED/EFFLUENT HEAT EXCHANGERS
METH
D-25-MP-101 NP
RECYCLE GAS/COMPRESSOR
D-25-MP-101 NP
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METHANOL SEPARATOR
C.W.
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DATE
BY
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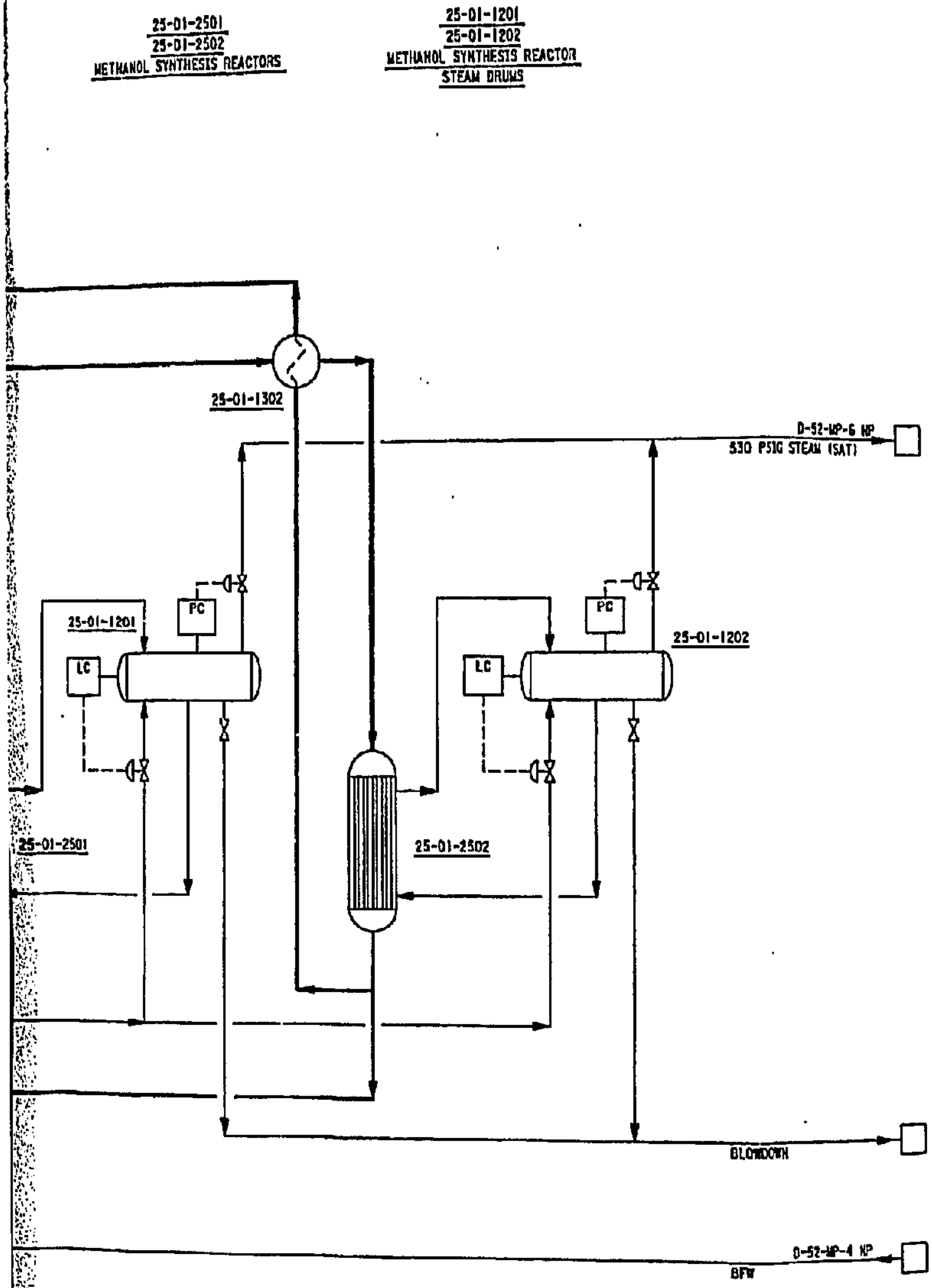

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| CHECKED | | |
| APVD SECT MG | | |
| APVD PROJ MGR | | |
| APVD CLIENT | | |

LURGI
Lurgi Kohle
und Mineraloeltechnik GmbH

RMP
THE RALPH M. PARSONS COMPANY
PASADENA, CALIFORNIA

U.S. DEPARTMENT OF ENERGY
BASKETT
W.R. GRACE & CO.
KENTUCKY
12,500 B.P.D.
COAL - TO - METHANOL - TO - GASOLINE PLANT

TITLE
PROCESS FLOW AND CONTROL DIAGRAM
METHANOL SYNTHESIS - UNIT 25
GAS REACTION

| SCALE | ACCOUNT NUMBER | JOB NUMBER | REVISION |
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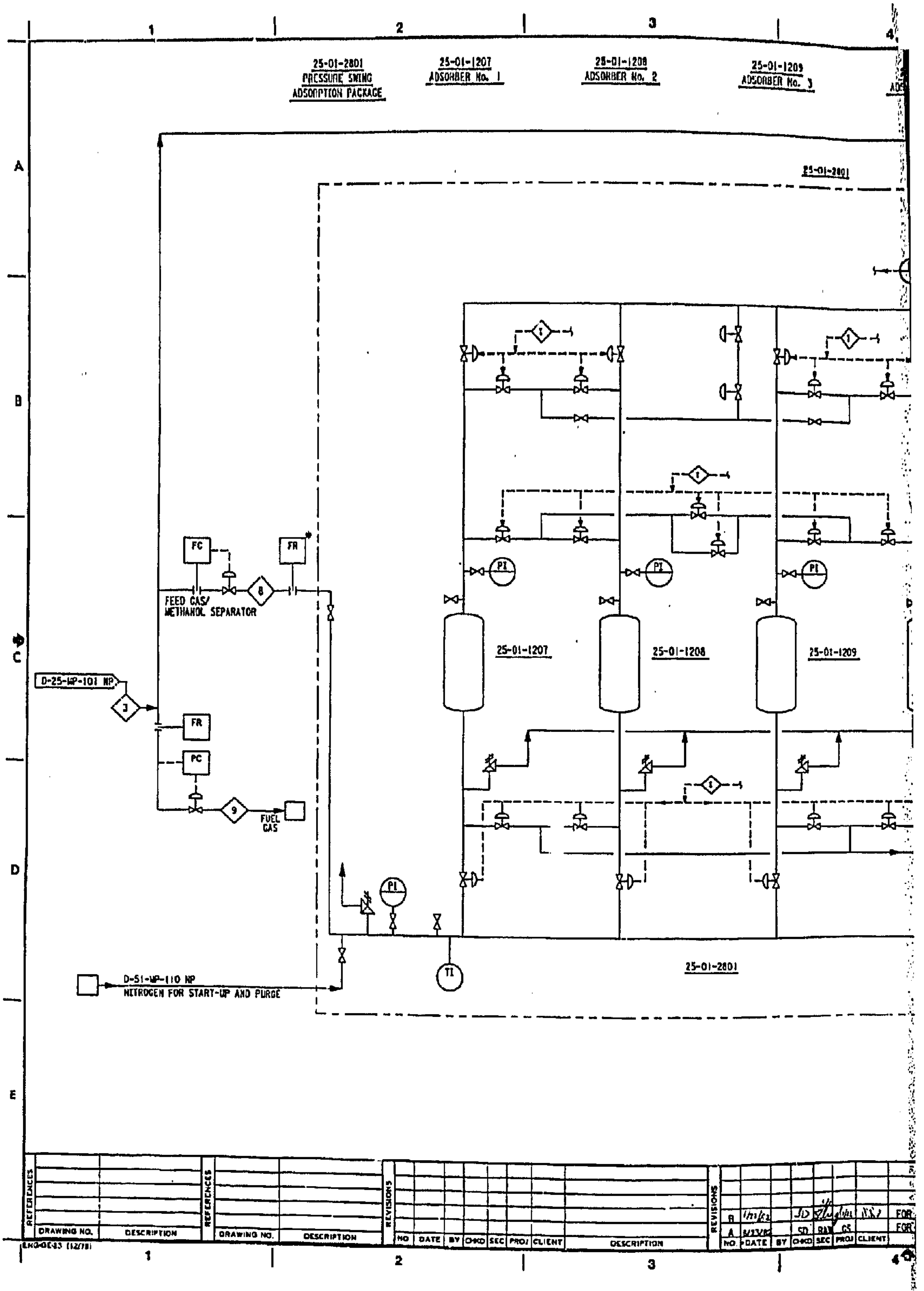
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ADSORPTION PACKAGE
25-01-1207
ADSORBER No. 1
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ADSORBER No. 2
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ADSORBER No. 3
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FEED GAS/
METHANOL SEPARATOR
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D-25-WP-101 NP
3
FR
PC
9
FUEL
GAS
PI
PI
PI
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25-01-1208
25-01-1209
PI
TI
25-01-2801
D-51-WP-110 NP
NITROGEN FOR START-UP AND PURGE
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DESCRIPTION
REFERENCES
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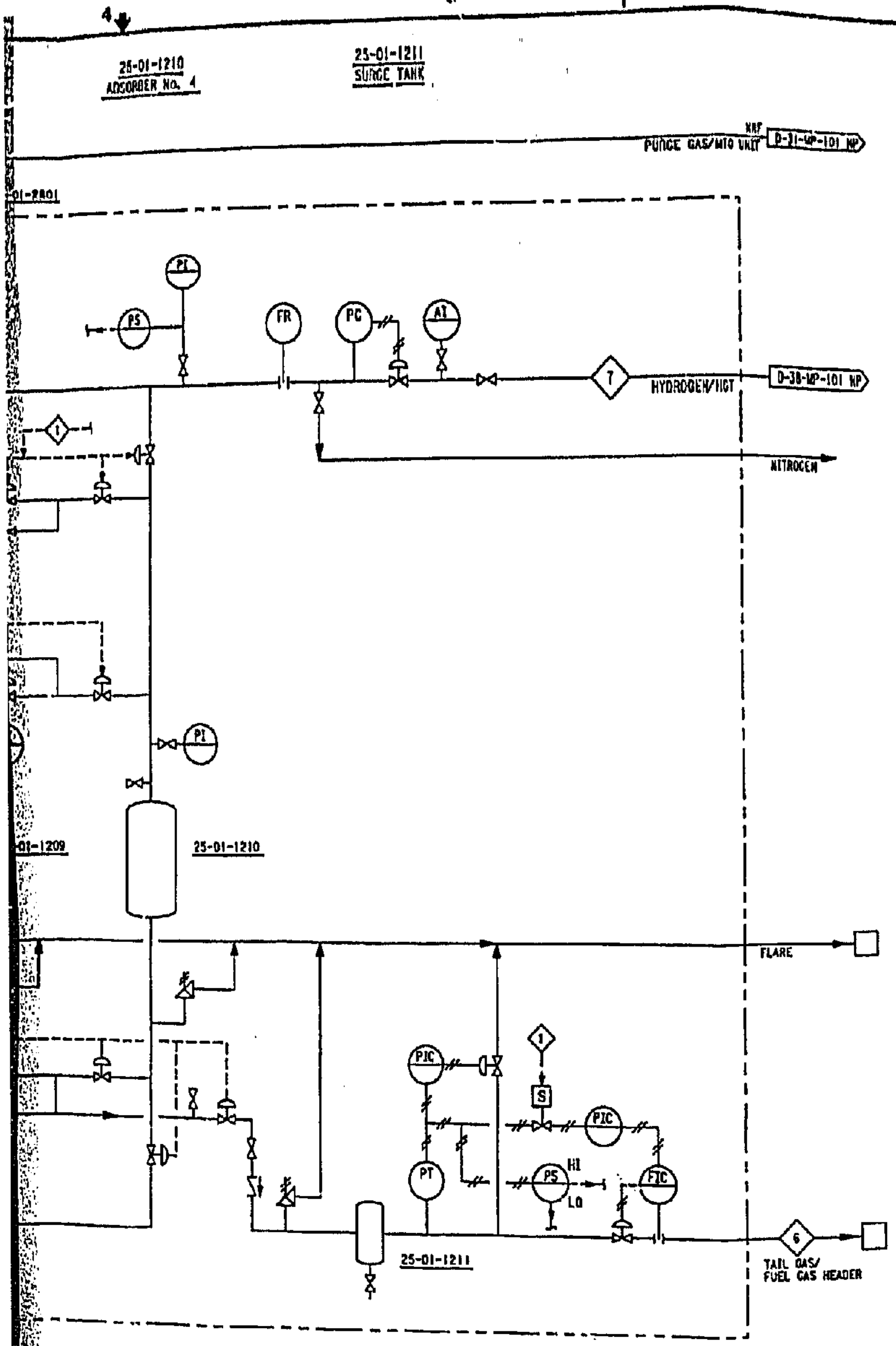

NOTES:

1. ALL PIPING, INSTRUMENTATION AND EQUIPMENT WILL BE FURNISHED BY OTHERS.
2. PANEL INSTRUMENTS MOUNTED ON LOCAL PANEL.

EQUIPMENT SHOWN ON THIS DRAWING:
25-01-2801

D25MP103N.DGA

U.S. DEPARTMENT OF ENERGY

BASKETT
KENTUCKY

**W.R. GRACE & CO.**
12,500 B.P.D.
COAL - TO - METHANOL - TO - GASOLINE PLANT

TITLE
PROCESS FLOW AND CONTROL DIAGRAM
METHANOL SYNTHESIS - UNIT 25
PRESSURE SWING ADSORPTION

| SCALE | ACCOUNT NUMBER | JOB NUMBER | REVISION |
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DOCUMENT NUMBER
D-25-MP-103 NP

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| CS | | FOR CLIENT APPROVAL | |
| PROJ | CLIENT | DESCRIPTION | |

FOR
DRAWN
CHECKED
APVD SECT MGR
APVD PROJ MGR
APVD CLIENT

THE RALPH M. PARSONS COMPANY
PASADENA, CALIFORNIA

| COMPONENT | MOL WEIGHT | ① MAKE-UP GAS (VAPOR) LBMOL/HR | MOL % | LBS/HR | ② LEAKAGE GAS (VAPOR) LBMOL/HR | MOL % | LBS/HR | ③ PURGE GAS (VAPOR) LBMOL/HR | MOL % | LBS/HR |
|---|---|---|---|---|---|---|---|---|---|---|
| $H_2$ | 2.02 | 24,203.44 | 67.54 | 48,794.13 | 125.65 | 69.98 | 253.31 | 870.82 | 71.43 | 1,759.58 |
| $CH_4$ | 16.043 | 80.65 | 0.22 | 1,293.83 | 4.58 | 2.55 | 73.56 | 54.02 | 4.43 | 866.60 |
| CO | 28.11 | 10,206.60 | 28.48 | .285,897.00 | 24.55 | 13.67 | 687.60 | 43.54 | 3.57 | 1,219.67 |
| $CO_2$ | 44.011 | 1,075.13 | 3.00 | 47,317.55 | 5.34 | 2.97 | 234.80 | 34.17 | 2.80 | 1,503.97 |
| $N_2$ | 28.02 | 203.55 | 0.57 | 5,702.73 | 14.51 | 8.08 | 406.44 | 161.49 | 13.25 | 4,524.24 |
| Ar | 39.94 | 68.32 | 0.19 | 2,728.70 | 4.39 | 2.44 | 175.24 | 50.16 | 4.11 | 2,003.19 |
| $CH_3OH$ | 32.043 | | | | 0.55 | 0.31 | 17.62 | 4.96 | 0.41 | 158.93 |
| HYDROCARBONS | 101.16 | | | | | | | | | |
| H. BOILER | 53.530 | | | | | | | | | |
| L. BOILER | 57.210 | | | | | | | | | |
| TOTAL DRY | | 35,837.69 | 100.00 | 391,733.94 | 179.57 | 100.00 | 1,848.57 | 1,219.16 | 100.00 | 12,032.18 |
| $H_2O$ | 18.02 | | | | | | | 0.01 | | 0.09 |
| TOTAL FLOW | | 35,837.69 | | 391,733.94 | 179.57 | | 1,848.57 | 1,219.17 | | 12,032.27 |
| MOL WEIGHT | | 10.93 | | | 10.29 | | | 9.87 | | |
| PRESSURE | PSIA | 750 | | | MAX. 750 | | | 994 | | |
| TEMPERATURE | °F | 82 | | | APPROX. 127 | | | 100 | | |

| COMPONENT | MOL WEIGHT | ⑥ PSA TAIL GAS TO FUEL GAS LBMOL/HR | MOL % | LBS/HR | ⑦ HYDROGEN LBMOL/HR | MOL % | LBS/HR | ⑧ PURGE GAS TO PSA LBMOL/HR | MOL % | LBS/HR |
|---|---|---|---|---|---|---|---|---|---|---|
| $H_2$ | 2.02 | 59.24 | 51.18 | 119.44 | 82.26 | 99.90 | 165.84 | 141.50 | 71.43 | 285.28 |
| $CH_4$ | 16.043 | 8.78 | 7.58 | 140.82 | | | | 8.70 | 4.43 | 140.82 |
| CO | 28.11 | 7.08 | 6.11 | 198.20 | | | | 7.08 | 3.57 | 198.20 |
| $CO_2$ | 44.011 | 5.53 | 4.78 | 244.39 | | | | 5.53 | 2.80 | 244.40 |
| $N_2$ | 28.02 | 26.18 | 22.62 | 733.44 | 0.06 | 0.08 | 1.75 | 26.24 | 13.25 | 735.19 |
| Ar | 39.94 | 8.13 | 7.03 | 324.72 | 0.02 | 0.02 | 0.80 | 8.16 | 4.11 | 325.52 |
| $CH_3OH$ | 32.033 | 0.81 | 0.70 | 25.82 | | | | 0.81 | 0.41 | 25.82 |
| HYDROCARBONS | 101.16 | | | | | | | | | |
| H. BOILER | 53.530 | | | | | | | | | |
| L. BOILER | 57.210 | | | | | | | | | |
| TOTAL DRY | | 115.75 | | 1,786.83 | 82.34 | | 168.39 | 198.1 | 100.00 | 1,955.23 |
| $H_2O$ | 18.02 | 8 PPMV | | 0.02 | | | | 8 PPM | | 0.02 |
| TOTAL FLOW | | 115.75 | | 1,786.85 | 82.34 | 100.00 | 168.39 | 198.1 | | 1,955.25 |
| MOL WEIGHT | | 15.44 | | | 2.04 | | | 9.87 | | |
| PRESSURE | PSIA | 60 | | | 650 | | | 994 | | |
| TEMPERATURE | °F | 100 | | | 110 | | | 100 | | |

| REFERENCES DRAWING NO. | DESCRIPTION | REFERENCES DRAWING NO. | DESCRIPTION | REVISIONS NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|

| REVISIONS NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT |
|---|---|---|---|---|---|---|
| B | 7/22/82 | | LD | [illegible] | [illegible] | [illegible] |
| A | 6/23/82 | | SD | RAW | GS | |

ENG-GE-23 (12/78)

NOTES:

1. MATERIAL BALANCE POINTS FOR THE METHANOL SYNTHESIS UNIT REFLECT NORMAL OPERATING CONDITIONS.

2. NORMAL OPERATING CASE IS BASED ON THE "DESIGN COAL ANALYSIS".

| | ◇4 FLASH GAS (VAPOR) | | | ◇5 "WILO" METHANOL (LIQUID) | | |
|---|---|---|---|---|---|---|
| BS/HR | LBMOL/HR | MOL % | LBS/HR | LBMOL/HR | MOL % | LBS/HR |
| 755.58 | 67.69 | 61.56 | 136.47 | 29.83 | 0.24 | 60.13 |
| 866.60 | 7.49 | 6.81 | 120.24 | 14.55 | 0.12 | 233.42 |
| 219.67 | 4.99 | 4.54 | 139.70 | 3.48 | 0.03 | 153.64 |
| 503.97 | 7.19 | 6.54 | 316.85 | 72.72 | 0.60 | 3,200.70 |
| 4,824.24 | 15.34 | 13.95 | 429.70 | 12.22 | 0.10 | 342.36 |
| 2,003.19 | 6.12 | 5.56 | 244.33 | 7.68 | 0.06 | 305.94 |
| 158.93 | 1.12 | 1.02 | 35.73 | 11,023.20 | 90.59 | 353,216.24 |
| | | | | 0.18 | | 17.70 |
| | | | | 13.26 | 0.11 | 710.08 |
| | 0.03 | 0.02 | 1.57 | 9.28 | 0.08 | 530.62 |
| 2,032.18 | 109.97 | 100.00 | 1,424.29 | | | |
| 0.09 | 0.01 | | 0.14 | 980.12 | 8.05 | 17,657.84 |
| 2,032.27 | 109.98 | | 1,424.43 | 12,168.50 | 100.00 | 376,428.67 |
| | 12.95 | | | 30.93 | | |
| | 415 | | | 415 | | |
| | 100 | | | 100 | | |

| | ◇9 PURGE GAS TO FUEL GAS HEADER | | |
|---|---|---|---|
| /HR | LBMOL/HR | MOL % | LBS/HR |
| 285.28 | 729.31 | 71.43 | 1,470.30 |
| 140.82 | 45.24 | 4.43 | 725.78 |
| 198.20 | 36.46 | 3.57 | 1,021.47 |
| 244.40 | 28.62 | 2.80 | 1,259.58 |
| 735.19 | 135.25 | 13.25 | 3,789.05 |
| 325.52 | 42.01 | 4.11 | 1,677.67 |
| 25.82 | 4.16 | 0.41 | 133.10 |
| | | | |
| | | | |
| | | | |
| 955.23 | 1,021.05 | 100.00 | 10,076.95 |
| 0.02 | 0.01 | | 0.08 |
| 955.25 | 1,021.06 | | 10,077.03 |
| | 9.87 | | |
| | 994 | | |
| | 100 | | |

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U.S. DEPARTMENT OF ENERGY

BASKETT W.R. GRACE & CO. KENTUCKY

12,500 B.P.D.

COAL - TO - METHANOL - TO - GASOLINE PLANT

LURGI Lurgi Kohle und Mineraloeltechnik GmbH

RMP

THE RALPH M. PARSONS COMPANY

PASADENA, CALIFORNIA

TITLE

MATERIAL BALANCE

METHANOL SYNTHESIS - UNIT 25

SCALE NONE | 2800 | 6182

DOCUMENT NUMBER D-25-MP-104 NP

REVISION B

FOR DESIGN REPORT

FOR CLIENT APPROVAL

PROJ | CLIENT | DESCRIPTION

FOR

DRAWN

CHECKED

APVD SECT HD

APVD PROJ MGR

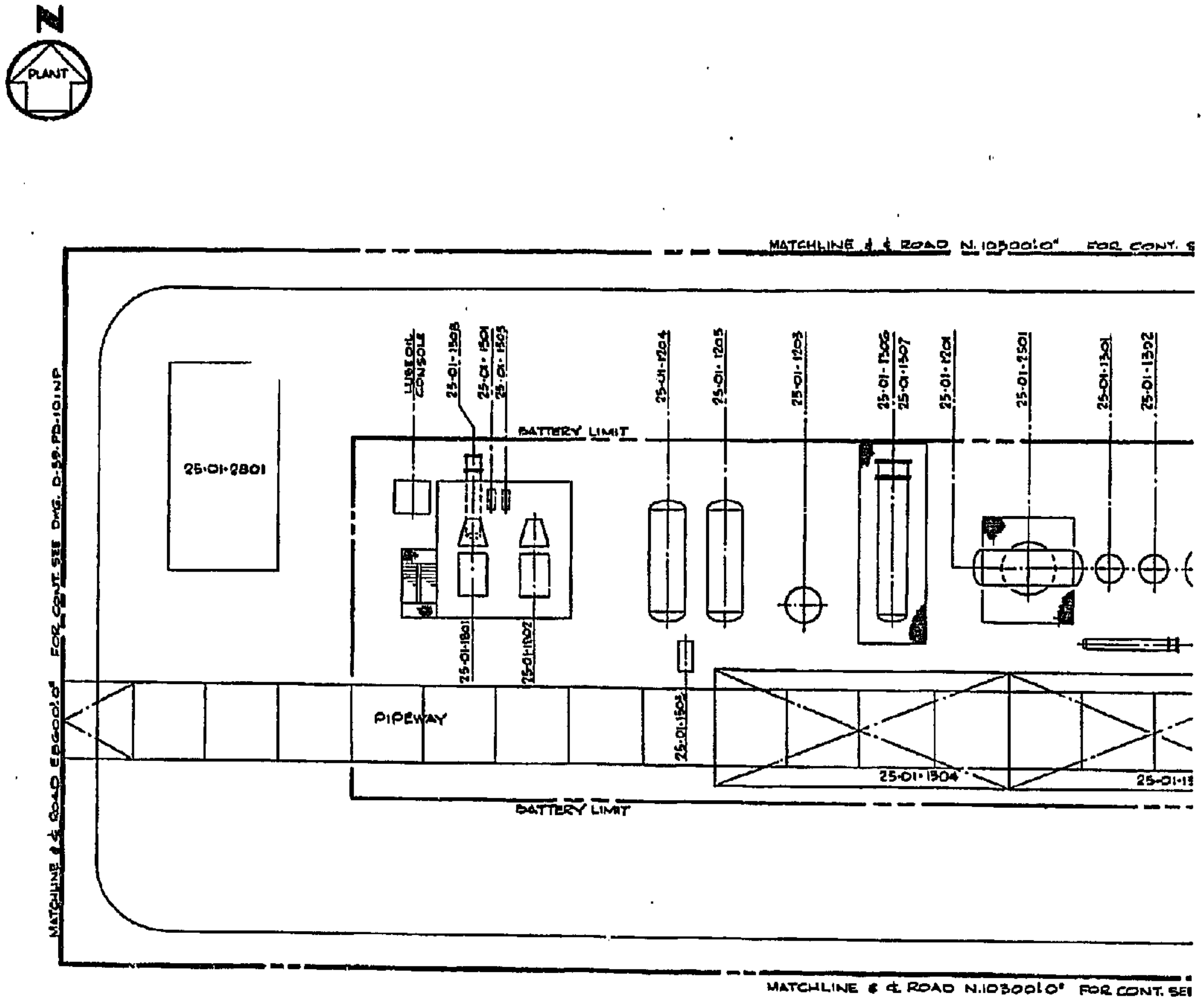
APVD CLIENT

## F. Plot Plan/General Arrangement Drawings

Plot Plan/General Arrangement Drawings for Methanol Synthesis Unit 25 are as follows:

| Drawing No. | Title |
|---|---|
| D-25-PD-101NP | Plot Plan - Unit 25 Methanol Synthesis |
| D-25-PD-102NP | Elevation - Unit 25 Methanol Synthesis |

p



MATCHLINE & ℄ ROAD N.10300'0" FOR CONT. SE

D

## EQUIPMENT LIST

| | |
|---|---|
| 25-01-1201 | METHANOL SYNTHESIS REACTOR STEAM DRUM |
| 25-01-1202 | METHANOL SYNTHESIS REACTOR STEAM DRUM |
| 25-01-1203 | METHANOL SEPARATOR |
| 25-01-1204 | METHANOL SEPARATOR BOTTOMS H.P. FLASH DRUM |
| 25-01-1205 | METHANOL SEPARATOR BOTTOMS L.P. FLASH DRUM |
| | |
| 25-01-1301 | SYNTHESIS REACTOR FEED/EFFLUENT HEAT EXCHANGER |
| 25-01-1302 | SYNTHESIS REACTOR FEED/EFFLUENT HEAT EXCHANGER |
| 25-01-1303 | BFW PREHEATER |
| 25-01-1304 | REACTOR EFFLUENT AIR COOLER |
| 25-01-1305 | REACTOR EFFLUENT AIR COOLER |
| 25-01-1306 | REACTOR EFFLUENT WATER COOLER |
| 25-01-1307 | REACTOR EFFLUENT WATER COOLER |
| 25-01-1508 | MAKE-UP GAS COMPRESSOR TURBINE CONDENSER |
| | |
| 25-01-1501 | M.U.G. COMPRESSOR TURBINE CONDENSATE PUMP |
| 25-01-1503 | L.P. FLASH DRUM PUMP |
| 25-01-1505 | M.U.G. COMPRESSOR TURBINE CONDENSATE PUMP (SPARE) |

25-01-1801
25-01-1802

25-01-2501
25-01-2502

25-01-2801

25-01-2802
25-01-2803

E

| REFERENCES | |
|---|---|
| DRAWING NO. | DESCRIPTION |
| D-25-PD-102NP | ELEVATIONS-METH. SYN. |

| REFERENCES | |
|---|---|
| DRAWING NO. | DESCRIPTION |

| NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT | DESCRIPTION |
|---|---|---|---|---|---|---|---|

| NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT | |
|---|---|---|---|---|---|---|---|
| B | 7/8/82 | RR | JD | [illegible] | [illegible] | MU | DESIG |
| A | 6/24/82 | [illegible] | JD | [illegible] | [illegible] | | CLIENT |

ENG-GE-23 (12/79)

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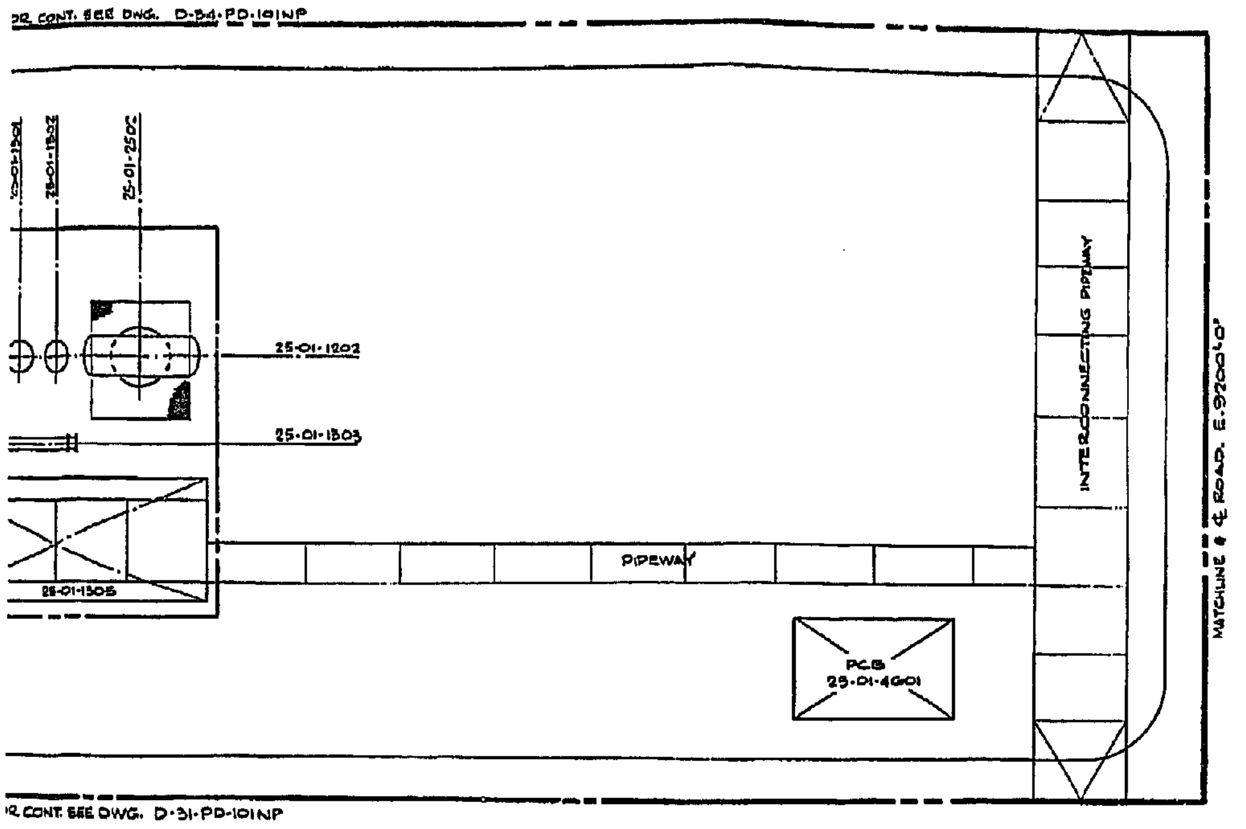


| | | |
|---|---|---|
| 1-1801 | MAKE-UP GAS COMPRESSOR | |
| 1-1802 | RECYCLE GAS COMPRESSOR | |
| 1-2501 | METHANOL SYNTHESIS REACTOR | |
| 1-2502 | METHANOL SYNTHESIS REACTOR | |
| 1-2801 | P.S.A. PACKAGE:- | |
| | 25-01-1207 | ADSORBER #1 |
| | 25-01-1208 | ADSORBER #2 |
| | 25-01-1209 | ADSORBER #3 |
| | 25-01-1210 | ADSORBER #4 |
| | 25-01-1211 | SURGE TANK |
| 1-2802 | L.P. FLASH DRUM EDUCTOR (NOT SHOWN) | |
| 1-2803 | CONDENSER EDUCTOR (NOT SHOWN) | |

1" = 20FT

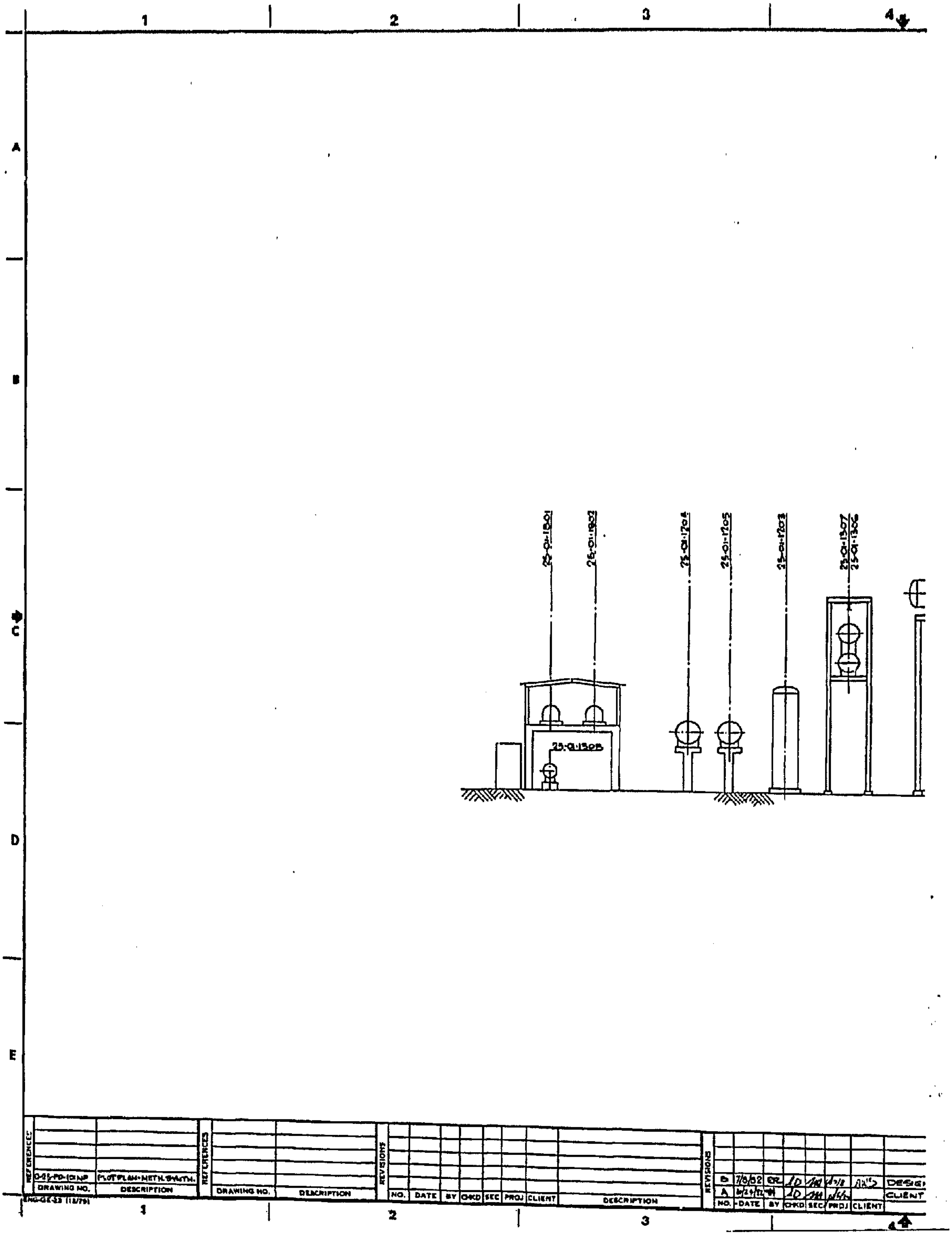
| | | |
|---|---|---|
| | | FOR |
| | | DRAWN |
| | | CHECKED |
| A | DESIGN REPORT | APVD SECT HD |
| | CLIENT APPROVAL | APVD PROJ MGR |
| CLIENT | DESCRIPTION | APVD CLIENT |

RMP
THE RALPH M. PARSONS COMPANY
PASADENA, CALIFORNIA

U.S. DEPARTMENT OF ENERGY
BASKETT W.R. GRACE & CO. KENTUCKY
12,500 B.P.D.
COAL - TO - METHANOL - TO - GASOLINE PLANT

TITLE
PLOT PLAN
UNIT 25
METHANOL SYNTHESIS

SCALE 1"=20'-0"
ACCOUNT NUMBER 7245
JOB NUMBER 6102
DOCUMENT NUMBER D-25-PD-101NP
REVISION B



| REFERENCES | |
|---|---|
| | |
| | |
| | |
| | |
| 0-25-PD-101NP | PLOT PLAN - METH. SYNTH. |
| DRAWING NO. | DESCRIPTION |

| REFERENCES | |
|---|---|
| | |
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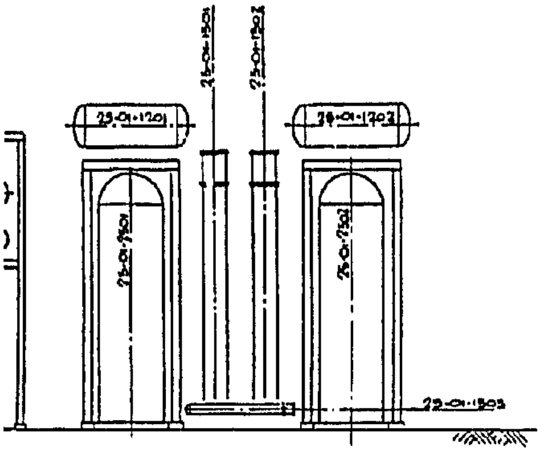
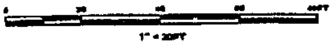
| | |
| DRAWING NO. | DESCRIPTION |

| REVISIONS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT | DESCRIPTION |

| REVISIONS | | | | | | | |
|---|---|---|---|---|---|---|---|
| B | 7/8/82 | ER | JD | [illegible] | [illegible] | [illegible] | DESIG |
| A | 6/24/82 | ER | JD | [illegible] | [illegible] | | CLIENT |
| NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT | |

ENG-GE-23 (12/79)





| | | |
|---|---|---|
| | | FOR |
| | | DRAWN |
| | | CHECKED |
| | DESIGN REPORT | APVD SECT HD |
| | CLIENT APPROVAL | APVD PROJ MGR |
| CLIENT | DESCRIPTION | APVD CLIENT |

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PASADENA, CALIFORNIA

U.S. DEPARTMENT OF ENERGY
BASKETT
**W.R. GRACE & CO.**
KENTUCKY
12,500 B.P.D.
COAL - TO - METHANOL - TO - GASOLINE PLANT

| TITLE | SCALE | CONTRACT NUMBER | JOB NUMBER | REVISION |
|---|---|---|---|---|
| ELEVATION<br>UNIT 25<br>METHANOL SYNTHESIS | 1"=20FT | 7243 | 6102 | B |
| | DOCUMENT NUMBER D-25-PD-102NP | | | |

## G. Single-Line Diagram

Single-Line Diagram for Methanol Synthesis Unit 25 is as follows:

| Drawing No. | Title |
|---|---|
| D-51-EE-105NP | One-Line Diagram - Units 25, 26, and 27 |

p

1 2 3 4

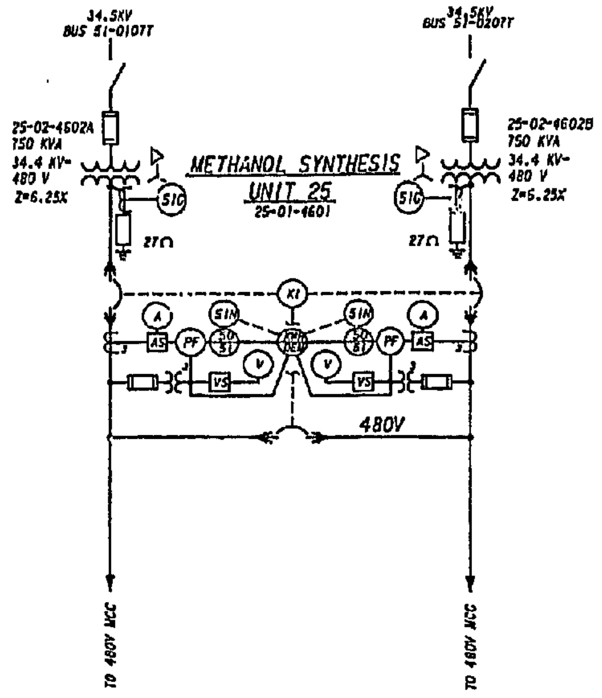
A

B

C

D

E



REFERENCES

| DRAWING NO. | DESCRIPTION |
|---|---|

REFERENCES

| DRAWING NO. | DESCRIPTION |
|---|---|

REVISIONS

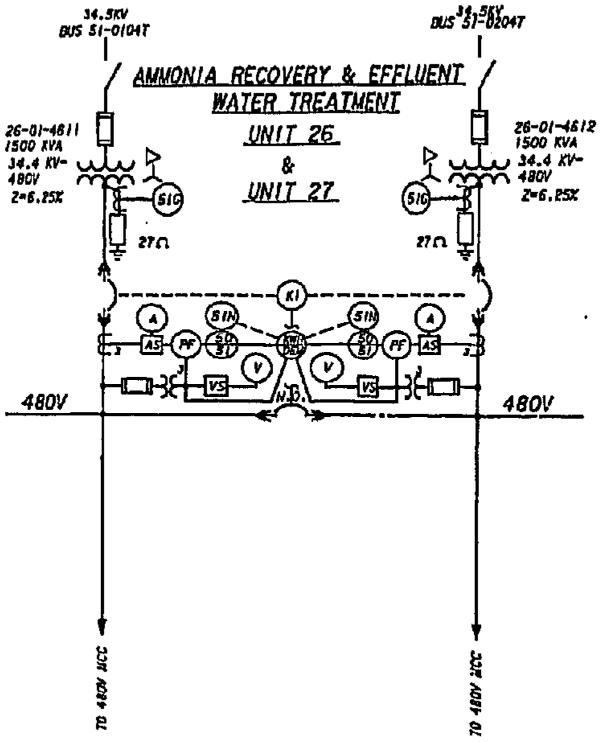
| NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT | DESCRIPTION |
|---|---|---|---|---|---|---|---|

REVISIONS

| NO. | DATE | BY | CHKD | SEC | PROJ | CLIENT | |
|---|---|---|---|---|---|---|---|
| B | 7-2-82 | LS | T.1 | [illegible] | [illegible] | [illegible] | FOR OE |
| A | 6-16-82 | HT | TS | RTB | | | ISSUED |

ENG-GE-23 (12/79)

1 2 3 4



U.S. DEPARTMENT OF ENERGY

BASKETT

KENTUCKY

**W.R. GRACE & CO.**

12,500 B.P.D.

COAL - TO - METHANOL - TO - GASOLINE PLANT

TITLE
ONE LINE DIAGRAM
METHANOL SYNTHESIS U-25
AMMONIA RECOVERY U-26
WATER TREATMENT U-27

| SCALE | ACCOUNT NUMBER | JOB NUMBER | REVISION |
|---|---|---|---|
| NONE | 4600 | 6182 | B |

DOCUMENT NUMBER
D-51-EE-105NP

FOR DESIGN REPORT
ISSUED FOR CLIENT APPROVAL

PROJ | CLIENT | DESCRIPTION

FOR
DRAWN HT
CHECKED
APVD SECT HD
APVD PROJ MGR
APVD CLIENT

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PASADENA, CALIFORNIA